MARCH • 1947
VOLUME XVIII NUMBER 6

the Petroleum Engineer

PIPE LINE NUMBER

...s for Operating Men

MEETINGS

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April 7-9—Mid-West Gas Association, annual meeting, Hotel Paxton, Omaha, Neb.
April 7-10—National Association of Corrosion Engineers, annual convention, Palmer House, Chicago.
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April 9—Institute of Petroleum, Manson House, 26, Portland Place, London, W. 1.
April 16-18—National Petroleum Assn., Hotel Cleveland, Cleveland, Ohio.
April 16-18—API Eastern District production meeting, William Penn Hotel, Pittsburgh, Pennsylvania.
April 17-18—Southern Gas Assn., Biloxi, Miss.
April 23-25—Natural Gasoline Association of America, Baker Hotel, Dallas, Texas.
April 24-26—Interstate Oil Compact Commission, Birmingham, Ala.
April 30-May 1-2—American Gas Association, Spring meeting, Stevens Hotel, Chicago, Illinois.
May 6-8—Petroleum Industry Electrical Association and Petroleum Electrical Supply Association, Rice Hotel, Houston, Texas.
May 6-8—Southwestern Gas Measurement Short Course, Univ. of Oklahoma, Norman.
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May 15-16—API Pacific Coast District, Biltmore Hotel, Los Angeles, California.
May 22-23—API Mid-Continent District Herring Hotel, Amarillo, Texas.
June 1-6—Society Automotive Engineers, Summer transportation meeting, French Lick Springs Hotel, French Lick, Ind.
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June 16-18—Canadian Gas Association, General Brock Hotel, Niagara Falls, N. Y.
June 16-20—ASTM, 50th annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
September 15-17—National Butane-Propane Association, annual meeting, Jefferson Hotel, St. Louis, Mo.
September 29-October 3 — American Gas Association, annual meeting, San Francisco.
October 10—California Natural Gas Assn., Fall meeting, Ambassador Hotel, Los Angeles.
October 21-25—Pacific Chemical Exposition, Civic Auditorium, San Francisco, Calif.
November 6-7—Society of Automotive Engineers, Fuels and Lubricants meeting, Hotel Mayo, Tulsa, Okla.
January 12-16, 1948—SAE, annual meeting, Book-Cadillac Hotel, Detroit, Mich.

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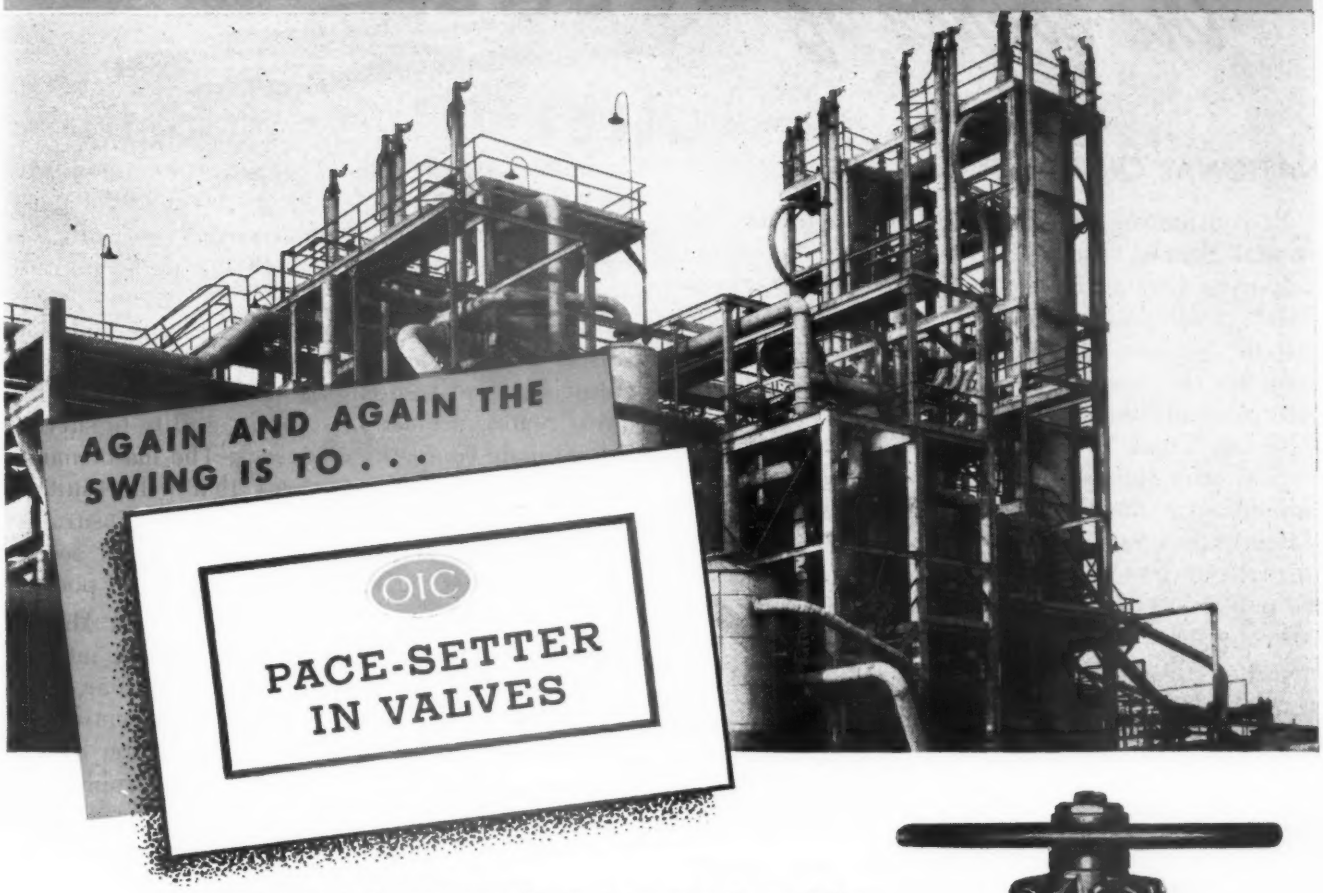

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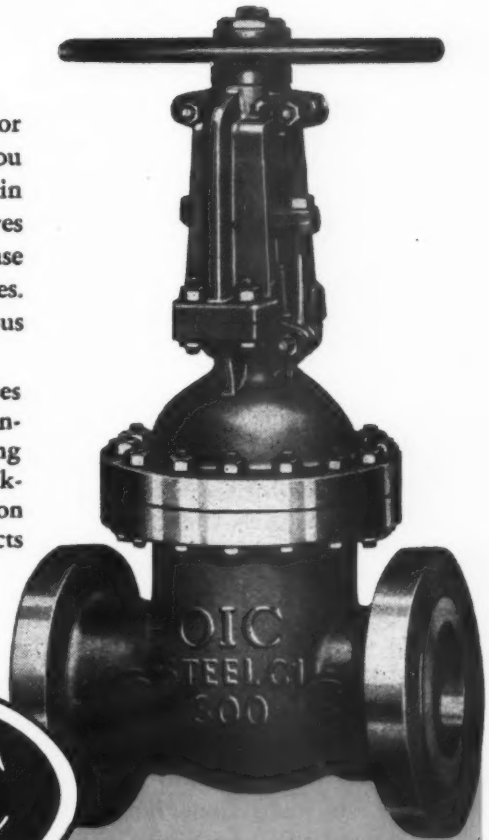

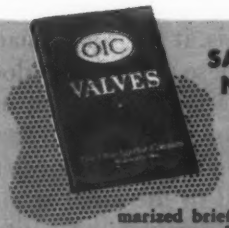

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NATIONAL OIL POLICY

In considering a national petroleum policy, the Special Senate Committee Investigating Petroleum Resources (Senator Joseph C. O'Mahoney, chairman) recommended in its Final Report that "to sustain our domestic supply of petroleum and to maintain the American system of competitive free enterprise at home and abroad," we should:

"First. Enact those laws which are most conducive to stimulating additional exploration and development in the United States. Encourage conservation to prevent waste. Promote interstate compacts so that our reserves may be expanded and used in the public interest, but guard against any danger of misusing conservation laws to restrain unduly any operator. Administer the public lands, not primarily as a source of governmental revenue, but for the purpose of stimulating private initiative in discovering and developing oil on the public domain.

"Second. Utilize the facilities of Government to promote research in the manufacture of synthetic liquid fuels, but without permitting governmental competition with private industry. Enact such legislation as may be necessary and proper to encourage secondary recovery from old fields which otherwise would not be productive.

"Third. Encourage free competitive enterprize by tax reforms to provide incentives for the risk of private capital in new ventures. Maintain the atmosphere in which competition may survive by enforcement of the antitrust laws. Adhere to the federal statute prohibiting interstate shipments of petroleum produced in violation of state law. Continue the provisions of the income-tax law permitting deductions for depletion and intangible drilling costs.

"Fourth. Require full disclosure to the appropriate agency of Government of the principal terms, conditions, and obligations by which American companies undertake to carry on oil business abroad.

"Fifth. Follow a foreign policy designed to promote full development of the petroleum resources of the whole world for the benefit of all peoples of the world; to secure adequate supplies of petroleum to all peoples; and to discourage artificial restraints and restrictions, both political and private, which deny full opportunity for the people of all lands to participate beneficially in the production and distribution of petroleum and its products."

Commenting on the second suggestion concerning legislation to encourage secondary recovery from oil fields, Senator E. H. Moore, a member of the Committee, stated that "The suggestion, however, raises the possibility of subsidy payments to those engaged in the 'secondary recovery' of oil. On principle, it is my opinion that any philosophy of government tending to subsidize uneconomic peacetime operations of any character is unsound and leads to a destruction of the virility of our private enterprise. If private enterprise is to survive in the United States, it must do so by its ability to survive all legitimate competitive hazards. The maintenance of a healthy domestic economy that will result in adequate competitive prices is the best insurance we can have for the continued operation of secondary projects and the preservation of stripper pools."

In regard to the third suggestion, Senator Moore, while approving the objective, stated in the interest of clarification that: "It should be made clear, however, that the production of oil and gas is entirely a local matter, wholly within the jurisdiction of the respective states, and that the primary problem of enacting and enforcing conservation measures to prevent waste of these natural resources is exclusively a state matter. The Congress should refrain from any policy that would tend to invade the prerogatives of the states in this purely local field."

Further, Senator Moore emphasized "that any governmental policy which encourages any department or agency of government to enter into competition with private enterprise, is contrary to this philosophy. As a corollary it follows that our national oil policy should be to discourage and, if necessary, to prohibit any department or agency of government from engaging in petroleum activities that directly or indirectly compete with our private industry.

"The Report properly points out that freedom of markets in international trade and equal access to petroleum supplies for all nations are contributing factors to world peace. In this connection, however, we should not fail to recognize that the United States is the only remaining nation in the world where the production of petroleum is not a governmental monopoly. With consciousness of this, it should be made clear that our agreement to these principles does not mean that we open the door to any foreign nation for the exploration of our domestic oil resources in competition with our private industry. Reciprocity in this regard should be limited to the citizens and nationals of foreign countries. Likewise, the United States Government should respect such policy by not engaging in the petroleum business abroad."

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SCANNING WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—The ghost of wartime priorities is stalking the oil and gas industries, emanating from the critical shortage of steel pipe.

The prospect of an over-all fuel shortage next winter, especially if new gas pipe lines are not completed, has prompted some government officials to look into possibilities of a voluntary reshuffle of delivery dates on "big inch" pipe. If that isn't enough, they are prepared to suggest that President Truman lay the matter before Congress with a view to obtaining legislation for mandatory priorities.

Officials involved are proceeding slowly because they realize the howl that will follow naturally from a nation weary of bureaucratic controls and just emerging from war shortages. It's one thing, however, for a family to wait another year for a new automobile, they say, but quite different when that same family faces a cold home because materials are lacking for transportation and distribution facilities.

Obviously, there is not enough steel now for all the pipe line projects and rehabilitation of oil facilities the world over, not to mention other industrial demands. So, the government may step in to decide which comes first, especially if the fuel shortage threat becomes more imminent.

Right now, there is a scramble for materials; first come, first served. There are no controls, except on exports and those do not apply, literally, until the material reaches the dock for loading.

It was in the export field that the question was first raised of limiting the first-come-first-served rule. It happened when the Commerce Department was confronted with Arabian-American Oil Company's application recently for an export license on the first batch of pipe—approximately 100,000 tons—for the Trans-Arabian pipe line.

Commerce Department was frightened at the responsibility of deciding whether Aramco's project should get preference over others pending. For example, Venezuela and Argentina have big pipe lines planned. Or was the pipe more urgently needed here in the United States? Commerce officials asked themselves. So, they put the question of what to do to Interior Department's interdepartmental petroleum committee.

This inter-agency group had already been advised by the Federal Power Commission that the current gas shortage was nothing compared with what could be expected next winter, unless pending projects received steel. Also, the group had been anxiously eyeing the pent up demand for oil burners, now being filled, foreshadowing a substantial increase in fuel oil demand. Aside from new housing, most of which was demanding oil or gas heat, there is a trend to convert from coal because of higher prices and strike-disrupted supply. More recently, some householders have turned to oil because gas companies are refusing new connections.

Congress recently received a report from FPC Chairman Smith on the current gas shortage extending from Colorado to the eastern seaboard. Due to greatly increased domestic requirements, Smith said, many gas companies had to order complete shutdowns of industrial service during cold spells. Even so, thousands of domestic consumers were at times without gas, Smith added.

Despite the contributions from the Big Inch lines this winter, 11 gas companies failed by a total of 575,505 MCF to meet their February peak-day load estimated at 3,442,505 MCF, according to the FPC chairman.

He pointed out that Tennessee Gas and Transmission Company had planned to increase its capacity by 118,000 MCF to 381,000 MCF but, because of the pipe shortage, had completed only 18,000 MCF. Now, T.G.&T. proposes to increase its capacity to 600,000 MCF. Completion date of this and other projects found to be required is conjectural, he added.

Smith said gas companies have emphasized their inability to obtain large-diameter pipe "because the tremendous demand for such pipe by oil companies for domestic and foreign operations, and by gas companies has far exceeded the capacity of the pipe fabricating mills."

(Senator Ed Moore, Oklahoma, has another reason for the gas shortage. He blames FPC for attempting to extend its powers to producing and gathering so that independent producers are fearful of selling gas to the interstate pipe lines lest they come under FPC's control. So, Moore and Rep. Rizley, Oklahoma, are sponsoring a bill to curb FPC's powers. Hearings begin April 14.)

On the other hand, the oil industry can make out a good case for new pipe lines to bring badly-needed crude to midwestern refineries, citing the impending big increase in fuel oil demand, which will come on top of a summer gasoline demand that may tax refining facilities to the limit.

(Speaking of gasoline demand, the military is having difficulty getting refineries to bid on its aviation gasoline requirements. Rceent bids failed by a wide margin to cover the 2,000,000 bbl of Grades 100/130 and 115/145 wanted for delivery beginning May 1. Prices, too, were higher than the military expected. It may be that insufficient notice was given, because the military was out of the avgas market for 18 months. During the fiscal year beginning July 1, the military's budget calls for worldwide purchase of 20,000,000 bbl of high-octane avgas.)

As to foreign oil projects, the State, War, and Navy departments would like to see development of American holdings in the Middle East and South America pushed with all possible speed. So, that is a factor, too.

Interior's Oil and Gas Division is studying the over-all outlook for fuel next winter. It is a good bet that OGD will decide something must be done. First step probably will be to tabulate all the large-diameter pipe line projects at home and abroad, listing their construction schedules. Then. OGD probably will suggest a voluntary re-arrangement of delivery dates, if necessary, to assure pipe for urgently needed gas and oil projects. If that fails, the problem is likely to wind up on the White House doorstep. Whether the President would attempt some administrative order for mandatory priorities, remains to be seen. With the War Powers Act slated to expire on March 31, some new legislation probably would be necessary.

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national petroleum situation

By H. J. STRUTH,* *Petroleum Economist*

HIGH DEMAND RATE. Demand for crude and refined products showed substantial gains in the first two months of this year, compared with 1946. Crude demand increased 5 per cent; motor fuel demand was up 8 per cent and fuel oil demand was 7 per cent above last year. High demand and relatively smaller output of fuel oils caused a further substantial reduction in all refined inventories during Feb.

IMPROVED STOCK POSITION. While combined stocks of refined products as of February 28 were about 14 per cent above a year ago, the total volume in storage reflects a decided improvement since the first of the year. Stocks of all refined products, including natural gasoline, have been reduced 21,800,000 bbl since January 1; fuel oil stocks showed a reduction of about 28,300,000 bbl. Motor fuel stocks on February 28 were about 9,200,000 bbl higher, reflecting efforts of industry to build up supply in anticipation of heavy spring and summer demand. Combined stocks of crude and products are now 4 per cent below normal working levels.

NEED FOR CRUDE. Reports of "shortages" of crude oil in some areas appear now to have some justification, particularly since stocks of refined products have been reduced substantially over the last two months. Heavy demand for products, which is above normal expectancy, is reflected by the economic position of both crude production and refinery runs. Actual demand for products in first two months of this year indicated need for refinery runs of 4,820,000 bbl daily. Actual runs averaged 4,793,000 bbl daily. Accordingly, crude production, after making allowance for imports, is shown to have been about 35,000 bbl a day below actual requirements. Average daily crude output in first two months of this year was 4,715,000 bbl.

DRILLING SUB-NORMAL. While all drilling has shown an increase since January 1 of about 9 per cent over last year, studies indicate that drilling of wildcat and development wells, excluding input and service wells, is lagging about 8 per cent below normal expectations.

*Editor, *The Petroleum Data Book.*

Comparative Statistics, February, 1947

*All figures are computed on a Bureau of Mines' Basis**

	Feb. 1947(p)	Jan. 1947(p)	Feb. 1946	This year to date	Last year to date	Per cent change
Wells drilling	3,810	3,900	3,750	3,810	3,750	+ 2
Total wells drilled§	2,201	2,513	1,954	4,714	4,311	+ 9
Development wells	1,852	2,122	1,710	3,974	3,722	+ 7
Oil	1,144	1,299	1,077	2,443	2,341	+ 4
Gas	246	259	199	505	400	+26
Dry§	462	564	434	1,029	981	+ 5
Per cent dry	24.9	26.6	25.4	25.8	26.4	— 0.6
Wildcat wells	349	391	244	740	589	+26
Oil	47	42	42	89	77	+16
Gas	14	10	9	24	18	+33
Dry	288	339	193	627	494	+27
Per cent dry	82.5	86.7	79.1	84.7	83.9	+ 0.8
Crude supply*	141,100	150,990	138,916	292,090	289,201	+ 1
Daily average	5,039	4,871	4,961	4,951	4,902	
Crude demand‡	139,400	154,800	135,085	294,200	280,633	+ 5
Daily average	4,979	4,994	4,824	4,986	4,756	
Crude stocks	228,500	226,800	231,827	228,500	231,827	— 1
Days supply	46	45	48	46	48	
Natural gasoline production	9,200	10,160	9,011	19,360	18,893	+ 2
Daily average	329	328	322	328	320	
Motor fuel production	59,850	67,760	55,492	127,610	117,618	+ 8
Daily average	2,138	2,186	1,982	2,163	1,993	
Gasoline yield, per cent	39.3	40.3	37.1	39.9	38.0	+ 1.9
Motor fuel demand‡	56,610	61,800	52,505	118,410	109,164	+ 8
Daily average	2,022	1,994	1,875	2,007	1,850	
Motor fuel stocks^	101,500	98,260	102,136	101,500	102,136	— 1
Days supply	50	49	54	50	54	
Fuel oil production	56,000	60,930	57,838	116,930	120,168	— 3
Daily average	2,000	1,965	2,066	1,982	2,037	
Fuel oil demand‡	73,700	82,000	67,352	155,700	145,084	+ 7
Daily average	2,632	2,645	2,405	2,639	2,459	
Fuel oil stocks	81,600	93,500	59,519	81,600	59,519	+37
Days supply	31	35	25	31	25	
Refinery still runs	134,600	148,160	130,232	282,760	270,362	+ 5
Daily average	4,807	4,779	4,651	4,793	4,582	
All refined stocks	265,200	275,500	232,602	265,200	232,602	+14
Days supply	46	48	44	46	44	

Economic Position of U. S. Petroleum Industry

Two Months Ending February 28, 1947

	Normal	Actual	Per cent of normal
Drilling*** (wells completed)	4,838	4,454	92
Production (daily crude output)	4,750	4,715	99
Refining (daily still runs)	4,820	4,793	99
Stocks (crude and refined)	514,300	493,700	96
Price of crude (per bbl)	$1.88**	$1.65	88

Crude Prices by States for February, 1947

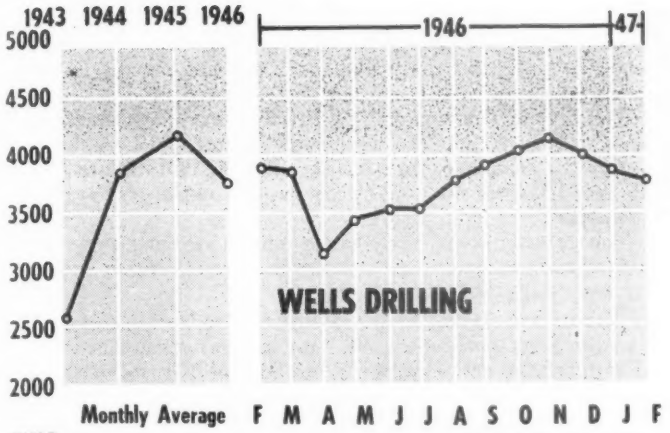
U. S. average	$1.65	Louisiana	$1.67	Basic crude prices	
Texas	1.66	Arkansas	1.48	Oklahoma-Kansas (36 gr.)	$1.62
California	1.41	New Mexico	1.45	Texas Gulf Coast (36 gr.)	1.85
Oklahoma	1.68	Mississippi	1.47	East Texas	1.70
Kansas	1.67	Illinois	1.84	West Texas (36 gr.)	1.49
		Other states	2.28	Calif. Signal Hill (26 gr.)	1.46
				Pennsylvania, Bradford	3.81

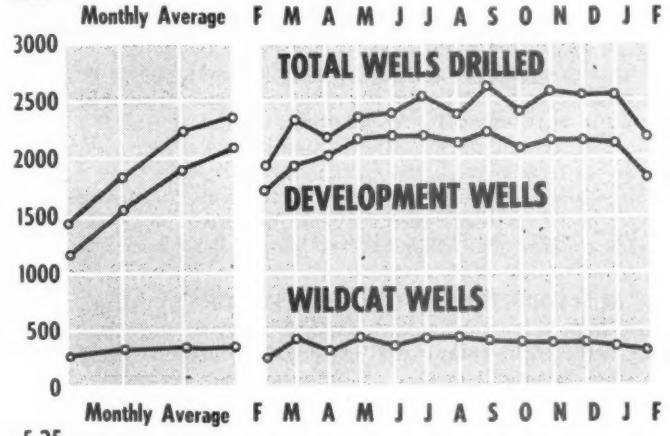
Drilling and Production Statistics by States

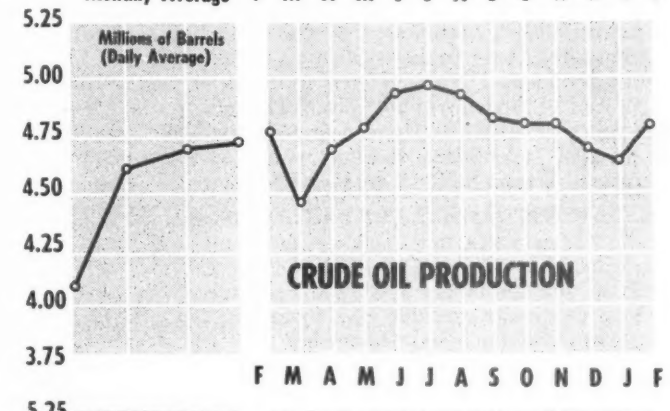
	Feb. 1947(p)	Jan. 1947(p)	Feb. 1946	This year to date	Last year to date	Per cent change
Total wells drilled	2,201	2,513	1,954	4,714	4,311	+ 9
Texas	648	625	559	1,273	1,234	+ 3
California	155	170	124	325	280	+16
Oklahoma	332	351	183	683	395	+73
Kansas	200	211	137	411	328	+25
Louisiana	94	102	95	196	197	0
Arkansas	14	23	19	37	30	+23
New Mexico	39	42	28	81	72	+13
Mississippi	22	35	14	57	37	+54
Illinois	126	166	135	292	313	— 7
Other states	571	788	660	1,359	1,425	— 5
Wildcats drilled	349	391	244	740	589	+26
Texas	120	116	92	236	200	+18
California	25	25	14	50	38	+32
Oklahoma	91	72	28	163	82	+99
Kansas	25	29	16	54	47	+ 15
Louisiana	14	20	15	34	25	+ 36
Arkansas	3	5	5	8	6	+ 33
New Mexico	5	5	2	10	12	— 17
Mississippi	9	11	5	20	10	+100
Illinois	20	40	24	60	65	— 8
Other states	37	68	43	105	114	— 8
Daily crude production	4,794	4,645	4,719	4,715	4,669	+ 1
Texas	2,065	1,952	2,103	2,005	2,068	— 3
California	876	881	848	879	843	+ 4
Oklahoma	366	359	388	362	387	— 6
Kansas	274	255	255	264	254	+ 4
Louisiana	419	423	379	421	376	+ 12
Arkansas	78	76	77	77	77	0
New Mexico	107	106	98	107	98	+ 9
Mississippi	85	86	55	86	55	+ 56
Illinois	191	197	210	194	208	— 7
Other states	333	310	306	320	303	+ 6

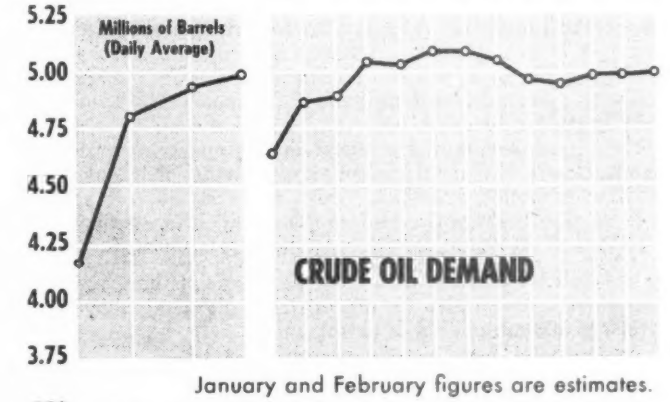
*Unless otherwise stated all figures represent thousands of barrels. ***Does not include input wells. (p) Preliminary. *Includes domestic production and imports.
‡Total demand, including exports. **Price 1926 (Index 100). ^Includes finished and natural gasoline. §Includes service wells.

PRELIMINARY ESTIMATES BASED UPON DATA FURNISHED BY AMERICAN PETROLEUM INSTITUTE, U. S. BUREAU OF MINES, STATE AGENCIES AND OTHER OFFICIAL SOURCES.

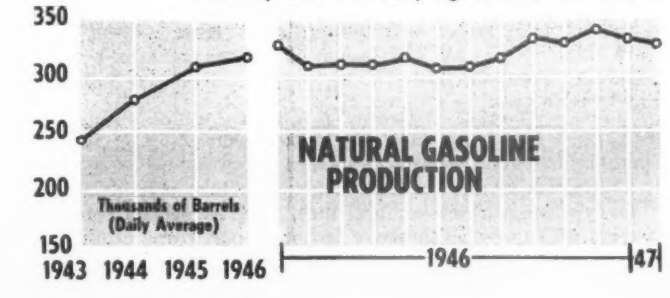


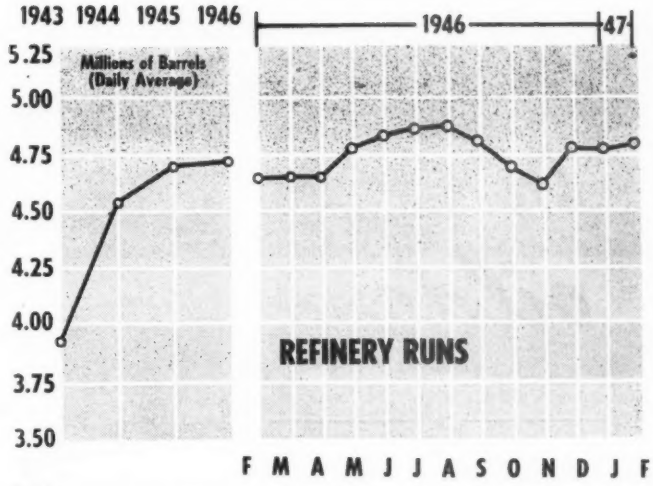


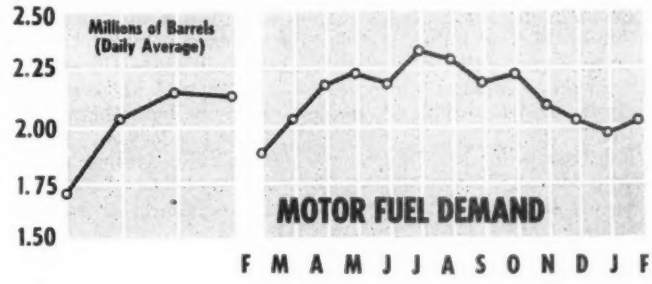


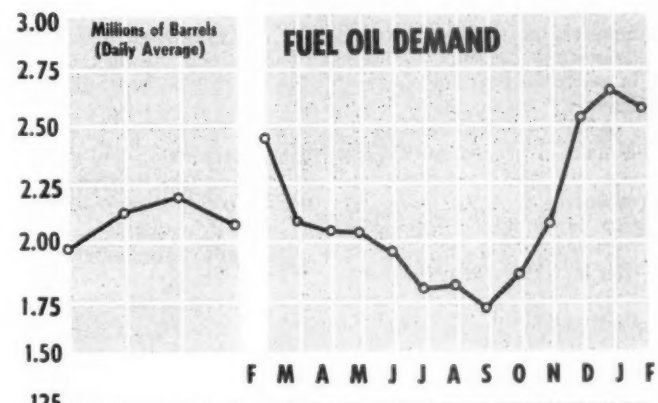


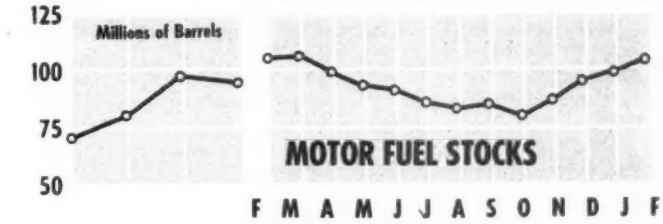
January and February figures are estimates.

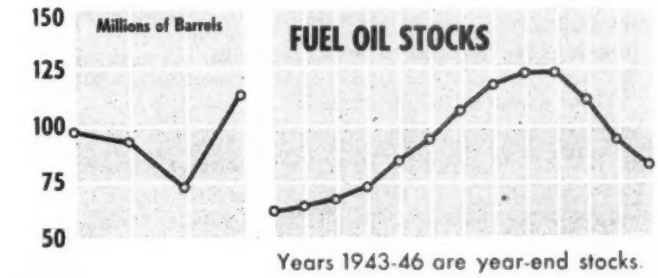




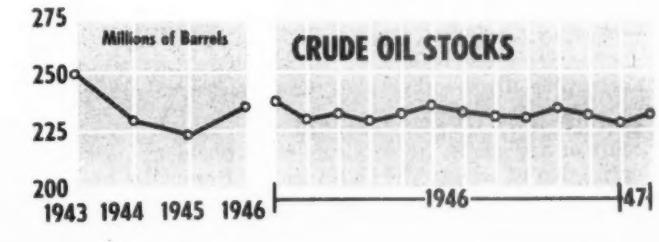




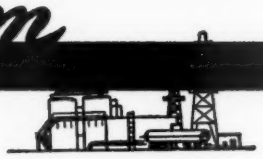




Years 1943-46 are year-end stocks.



highlights in oildom



● **TO RESUME PHILIPPINE DRILLING.** Far East Oil Development Company, Inc., soon will resume war-interrupted test drilling on Cebu to determine whether petroleum can be found in commercial quantities in the Philippines. Oil seepages were found in the Philippines as early as 1914 but some geologists say commercial deposits may never be found because the island's rock structures permit oil and gas to leak into the sea. Far East geologists, however, contend former drilling was not deep enough—that producing structures are below 12,000 ft. Far East is financed jointly by Andres Soriano, Manila businessman, and the Capitol Corporation of California.

● **TIDELANDS STATUS TO BE DEFINED.** Legal counsel for the U. S. Department of Interior collaborating with Department of Justice officials, are drawing up a special executive order defining the status of the rich oil fields along coastal California in event the Supreme Court decides the tidelands belong to the federal government.

After a meeting between justice officials, the Bureau of Land Management, and representatives of Interior's oil and gas division, attorneys for the two departments began studying legal measures to protect present lessees by placing them in a special class in which they will not be considered as trespassers.

This action will be taken in event Congress does not enact further legislation in the meantime, recognizing present claims of states to coastal lands, both in regard to mineral and surface rights within the three-mile limit.

It is understood that the government group has agreed that everything possible will be done to prevent disruption of present operations in these fields, pending development of federal policy.

States most vitally concerned in event the court decides in favor of the federal government are California, Louisiana, and Mississippi, with a secondary interest in Texas because of the agreement between it and the government when it was taken into the Union in 1846.

Officials also agreed there would be no retroactive suits to collect royalties previously paid the states.

● **REPRESSURING PLANNED.** A project is planned by producers in the Cache Creek pool of Cotton County, in southwestern Oklahoma fields, to build a repressuring plant and buy gas from the Lone Star Gas Company of Dallas, Texas, to inject into the sands. It is said the plant will be in operation by May 1.

There are at least 317 producing wells in the county, 226 at Cache Creek, which also had 14 drilling tests and 5 locations.

● **RATABLE TAKING UPHELD.** The Oklahoma Supreme Court, by unanimous decision, has affirmed authority of the Corporation Commission to direct the ratable taking of gas, and held that an order of the commission requiring the Republic Natural Gas Company to make a connection with and take gas ratably from a well of the Peerless Oil and Gas Company in the Guymon-Hugoton field of Texas County, or to cease production from the common source of supply, was not arbitrary nor beyond the jurisdiction of the commission.

● **UPHOLDS UNIT PRINCIPLE.** The United States circuit court of appeals at New Orleans has upheld the principle of unitization of oil and gas leases in a suit orginally brought by Mrs. Virginia Y. Scott et al against Seaboard Oil Company.

The court held that royalty owners may not refuse to cooperate with their lessees for their mutual protection in the adoption of the customary method of operation universally used in the field and at the same time demand damages.

Plaintiffs had refused to join in the unitization of the Long Lake field of Anderson County, east Texas, and brought suit against the companies for damages, claiming that wet gas under the land has been replaced by dry gas as a result of the cycling operations.

The appeals court said the contention of such persons is unique and untenable, and that any damages that they suffered are not chargeable to the lessees.

● **TO LEASE TIDELAND ACREAGE.** The Texas school land board expects to lease this year for mineral development part of a 10,000,000-acre expanse in the Gulf of Mexico, extending nearly 27 miles from the coast.

Texas claims officially all the submerged area within 27 miles of its coast, and more recently has been contending the state boundary extends to the Continental Shelf, subsequent to President Truman's assertion of the national domain to that distance.

More than 100 oil and gas wells are located in tidewater areas of Texas, but extensive drilling never has been attempted very far from shore. Land Commissioner Bascom Giles has received several requests to lease out to 25 miles, and the new land board has ordered the 10,000,000 acres surveyed. It intends to offer it in 640-acre tracts, and call for leases later on 5760-acre plots farther at sea.

● **SUMATRA OPERATIONS AWAIT SURVEY.** Resumption of oil operations in Sumatra depends on how soon the producing fields are re-entered and inspected, according to E. N. Leibacher. general manager of Nederlandsche Koloniale Petroleum Maatschappij, East Indies affiliate of Standard-Vacuum Oil Company. Leibacher said he hoped the company's South Sumatra oil fields could soon be visited by NKPM production technicians. These fields supplied oil to the company's 45,000-bbl-a-day Soengei Gerong refinery near Palembang. The present condition of the fields is not known. The refinery was blown up in February, 1942, by Dutch forces, but is being restored by some 2000 Indonesians. Rate of restoration is expected to be increased when additional food supplies become available.

● **TENNESSEE JOINS COMPACT.** Membership of the Interstate Oil Compact Commission was increased to 18 states when Governor Jim Nance McCord signed the Compact following passage of a bill by the Tennessee legislature authorizing such action. Originally executed by six states in 1935, the Compact has expanded until its membership now embraces states in which is produced more than 90 per cent of the nation's gas and 80 per cent of the crude oil.

● **SIMULTANEOUS ANALYSES.** Simultaneous determination of the oil and water saturations of oil field cores has been made possible by apparatus developed by the U. S. Bureau of Mines in cooperation with the state of Oklahoma and now widely used in the petroleum industry.

Combining accuracy and simplicity of operation with economical costs, the apparatus employs a single, continuous distillation-extraction process in which water in the core sample is evaporated by vaporized toluene, and the oil in the sample is dissolved by the condensed toluene returning to the heating flask.

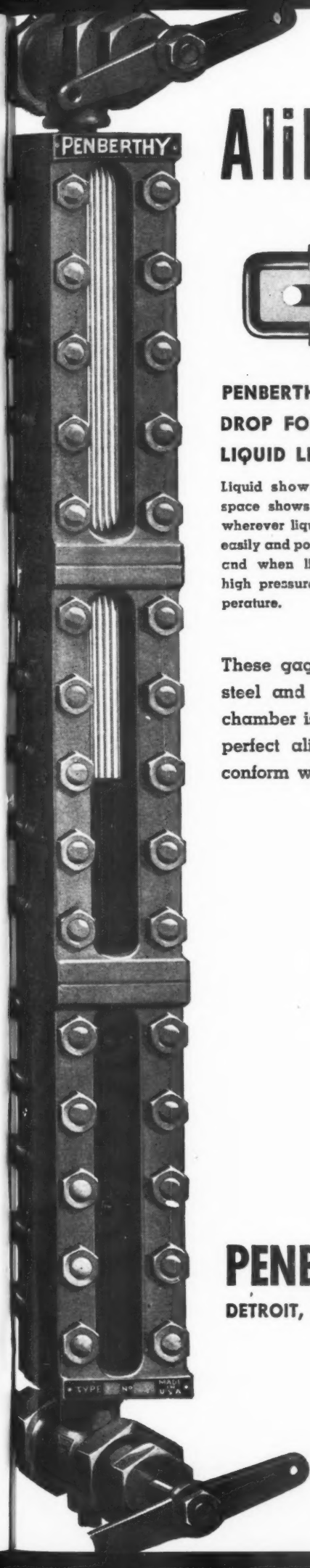
● **ALASKAN OIL PROSPECTS.** Navy officials have revealed that current exploration for oil in Alaska ultimately may bring in 300 to 500 million bbl of petroleum.

An official of Naval Petroleum reserves stated:

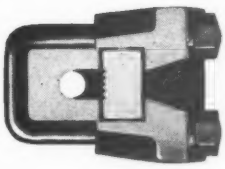
"Ultimately, we hope to get 300 to 500 million bbl from the reserve. An average new field in the United States today has an ultimate production of only two million barrels."

He said that "in addition, some of the coastal area between Nome and Point Barrow, Alaska, outside the reserve might be found productive" of oil.

● **CHINA OIL AGENCY.** The government news agency at Shanghai has announced activation of a new agency capitalized at 600 billion Chinese dollars (approximately $179,000,000 at official exchange rates—or half that, at black market rates) to develop a Chinese oil industry and to import foreign oil. First petroleum imports already have been ordered from Iran, it said



Alike in Quality



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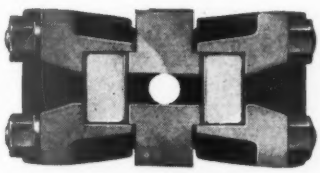
These gages are made of alloy temperature resisting steel and are the highest quality throughout. Liquid chamber is made from a solid block of steel to assure perfect alignment and rigidity. All Penberthy gages conform with A.P.I.-A.S.M.E. requirements.



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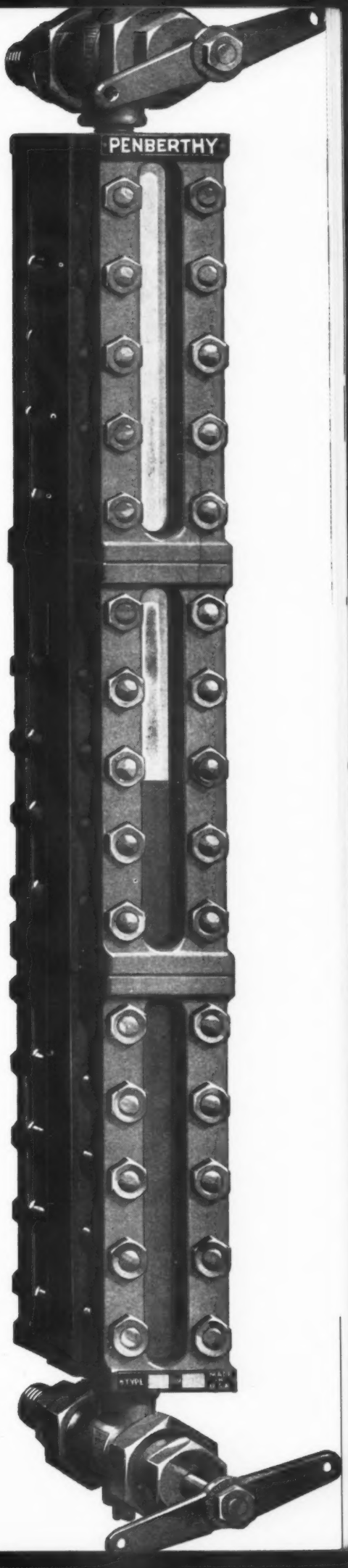
Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged...similar to Reflex types.

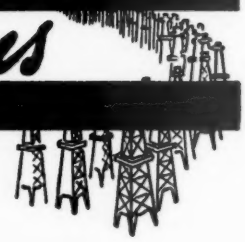


PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN • Canadian Plant; Windsor, Ontario

PENBERTHY PRODUCTS

current oil field operations



Exploration wells that have found production

● **KANSAS.** Continental 1 Warren Mortgage, Northwest Burnett pool discovery, Ellis County. Swabbed 400 bbl/3¾ hr. from 3570 ft in Arbuckle sand. Rated maximum Kansas potential of 3000 bbl.* Offset, Shell 1 Ridler, is said to be largest producer in state with 82,935 bbl potential.

Bay Petroleum and HH&B Drilling 1 Handyshell, NE SE SW 31-20-15, Barton, 477 bbl. 3850 ft TD. Arbuckle 2787 ft.

Drillers Gas 1 Dinsmore, SW SW NE 36-19s-9w, Rice. 2.5 MMCF from 1970 85 ft. TD 3293. Recomp.

Stanolind 1 Sealy, NW NW NW 25-30s-18w, Kiowa County. Swabbed 6 bbl/2 hr 33 grav from 5110-35 ft.

Cities Service 1 Becker, C SW NW 32-22-15w, Pawnee County. 24 MMCF gas from Arbuckle lime at 4044-142,ft.

Drillers Gas 1 Lowery, CSE SW 36-19-9w, Rice County. 7 MMCF from Tarkio at 2117-27 ft. Prospect.

W. L. Hartman 1 Rempke, NW NW SE 21-9n-18w, Rooks County. Swabbed 14 bbl an hr from 3579-92 ft.

● **LOUISIANA.** Sohio 2 Farmers Land & Canal, 26-10s-7w, Calcasieu Parish. Flowed 292 bbl 37.5 gravity from 10,350-70 ft.

Curtis Kinard 1 Ayers Timber, 19-15n-10e, Madison Parish. Tested 14 bbl cond, 1.4 MMCF in 6 hr 5630-9 ft Tuscaloosa.

Rogers Lacy 1 Pace, SE NW 28-13n-6w, DeSoto Parish. Flowed 30 bbl/1½hr, also water, 6326-36 ft. Testing.

Superior Oil 3 Louisiana Ld. & Ex. Four Isle pool (abandoned 1938), Terrebonne Parish. Flowed 80 bbl 41 grav from 9878-94 ft. Reopened pool.

● **ILLINOIS.** National Associated 1 Baye, NW NE NW 21-4n-4e, Marion. 38 bbl 2205-10 ft. Aux Vases. Comp.

Phillips 1 Spiker, NE SE SW 23-3n-5e, Clay. Pumped 95 bbl 2585-614 ft. Cypress. 3058 TD. Comp.

NuEnamel 1 Adams, SW NE SE 10-6n-7e, Effingham. Oil from 2835-45 ft Rosiclare. TD 2878 ft.

● **CALIFORNIA.** Standard-Bolsa Chica 73-30 V, 30-23s-19e, Kettleman Hills, Kings. Flowed 500 bbl, 2 MMCF from new deep Eocene zone. TD 12,389 ft.

● **TEXAS.** G. C. English 1 Madison, Blk 10 Juan Delgado sur. Brown County. Flowed 99 bbl 42 grav oil from 2245-51 ft.

Plymouth Oil. Ector County. Flowed 50 bbl/hr from 8437-99 ft. in Ellenburger.

Fogelson & Ingleright 1 Lones. 64-11-T&P. Pumps 50 bbl from 3061-73 ft in Strawn sand.

John F. Camp & Sons 1 Camp Fee, SW Medina County. Swabbed 36.08 grav oil from Navarro at 2050-240 ft. Testing.

Shell I University, 21-39-N. Crockett. Sprayed oil and gas from 8284 ft TD in Ellenburger, topped at 8040 ft. Testing.

Sinclair Prairie 15-A Cox, Walnut Bend pool, Cooke County. 272 bbl oil upper Strawn (new) 2993-3004 ft. Company's 20 Atkins, same pool, had 205 bbl/8 hr from 5221-9 ft (new sand).

Stanolind 1 Halsell, J. Shearer sur, Foard County. Swabbed 16 bbl/4 hr from 4822-38 ft in Strawn lime.

Anzac Oil 1 C. V. Evans, near Bead Mt., Coleman County. Flowing 10 bbl/hr from lower Fry sand, 2932 ft.

Fred Manning 1 Record, 1609-TE&L, Throckmorton County. 360 bbl from Mississippian, 4673-700 ft.

Shell 2 Neuhaus, Provident City field, Lavaca County. Flowed 132 bbl 46.2 grav, new zone 5403-12 ft.

W. T. Graham 1 A. L. Harris, Sec 3, Hooper & Wade sur, Archer County. Drillstem test oil from 5144-200 ft. Mississippian. Prospect.

L. T. Burns 1 R. O. Andrews, TE&L sur, bk 1806, Archer County. Flowed 80 bbl/8 hr 4454-68 ft Caddo lime.

Humble 1 Turner, 43-27-T2s, W. T. Holcombe Sur, Midland. Pumper 139 bbl 40.1 grav in 2 2hr. Wolfcamp limestone 8500-65 ft. TD 11,445 ft. Comp.

Atlantic 1 Mrs. J. R. Parr, N. Minnie Bock field, Nueces. 90 bbl. 7680-9 ft. New zone.

R. C. Dublin et al 25 R. Campbell Est. 1382-TE&L sur, Archer. Pumped 21 bbl 38 grav. Gunsite 956-60 ft. TD 992 ft. Comp.

● **COLORADO.** Florence & Teague 1 C. C. Fitzhugh, 4 mi north N. Mex., Archulata County. Pumped 210 bbl 32 grav/18 hr from Mancos shale at 470 ft.

● **KENTUCKY.** Pure-Stanolind 1 Hammons, 2-H67, Clay County. Filled up 2500 ft 40 grav oil from Knox dolomite. 3514 ft TD. 3514 PB.

● **MICHIGAN.** Sun Oil 1 Linderer, SW SW SW 11-12n-13w, Newaygo County. 11 bbl/hr from Traverse limestone, 2331-3 ft.

● **NEW MEXICO.** Devonian Oil 1 Federal, 19-9s-38e, Lea County. Flowed 147 bbl from San Andres lime, 4945-5012 ft. To install pump.

● **OKLAHOMA.** Carter Oil 1 McIntosh, NE NW NW 19-4-2w, Garvin County. Drillstem test 25 bbl/hr 3 MMCF at 7341 ft.

McIntyre, Sherman & Cunnings 1 Simpson, NE NW NE 30-15n-12e, Okmulgee County. Swabbed 10 bbl/hr from 2750-5 ft Wilcox. Drilling.

Standard of Kansas 1 Looney, SW SE SE 15-10n-7e, Seminole County. Drillstem test, 720 ft oil 3445-65 ft. New zone. Booch.

Amerada 1 Jacobs, SW SE NE 13-1s-6w, Stephens County. Flowed 329 bbl 42.5 grav 2962-95 ft TD 4968.

Aladdin 1 McGinley, NW NW NW 9-19n-1w, Payne County. Est. 200 bbl oil 4881-86 ft Wilcox. New zone.

Texas 1 Denney, NE NE NE 1-2s-4w, Stephens County. Drillstem test oil from 6800-21 ft.

Burton et al. 1 Indian, NW NE NE 20-3s-12w, Cotton County. Swabbed and had 250 ft. oil at 1482 ft.

Hood & Neeld 1 Shaw, NW NE NE 28-3s-11w, Cotton County. Hole almost filled with oil. TD 1524 ft.

Pray & Bauman 1 Ainsworth, C NW SE 26-5n-4w, McClain County. Flowed 516 bbl from 9892-940 ft in Hunton.

C. L. Carlock 1 Harrison, NE NW SE 25-5n-4w, McClain County. Flowed 480 bbl/20 hr 44 grav oil, 5 MMCF gas from 10,707 ft Wilcox. Testing.

Dennis Gartner 1 C SE NW 15-18n-17e, Wagoner County. Hole filled 135 ft in 10 min from 846-55 ft in Wilcox. Testing.

Gulf 1 Bliss, SE NW NE 26-17-1, Logan County. Drillstem test oil and gas at 5028-70 ft. Testing.

R. Olson Oil 1 Ott, CW SW SE 4-21-9w, Major County, 3.5 MMCF, 40 bbl cond per MMCF. 8015-8124 ft. Wilcox.

Coline Oil 1 Cooper, SE NW SE 1-2n-8w, Stephens. Flowed 15 bbl/hr 40 grav. 9015-40 ft. Pennsylvania.

C. C. Harwell 1 Greer, SW SW SW 24-23n-1w, Noble. Flowed 185 bbl 43.5 grav 5370-95 ft Bartlesville TD 4395. Comp.

West Edmond gets quarter mile south extension with Sinclair Prairie 2 Clausewitz, C SE NE 9-12n-4w, Oklahoma County. 397 bbl/11.5 hr 7125-60 ft.

Leach & Warren 1 Meadors, NE NW SE 8-9n-10e, Hughes County. Head flows from 2925-55 ft in Gilcrease sand.

F. A. Gillespie & Sons 1 Meadors, NW NW SW 31-8n-9e, Hughes County. Swabbing 75 bbl oil daily from 2791-2811 ft in Booch sand.

J. E. Crosbie, Inc. 1 Schultz, SE NE SW 30-12n-7e, Okfuskee County. 250 ft oil on drillstem from 3344-64 ft. New zone.

Stauffer Petroleum 1 Hall NE NE SE 9-25n-7w, Grant County. Some oil and gas 3100-3450 ft Hoover-Tonkawa sand. Drilling.

● **MISSISSIPPI.** Texas Pacific Coal & Oil 2 Wilson, LaGrange field, Adams County. New shallow production 4635-41 ft, Wilcox zone. Testing.

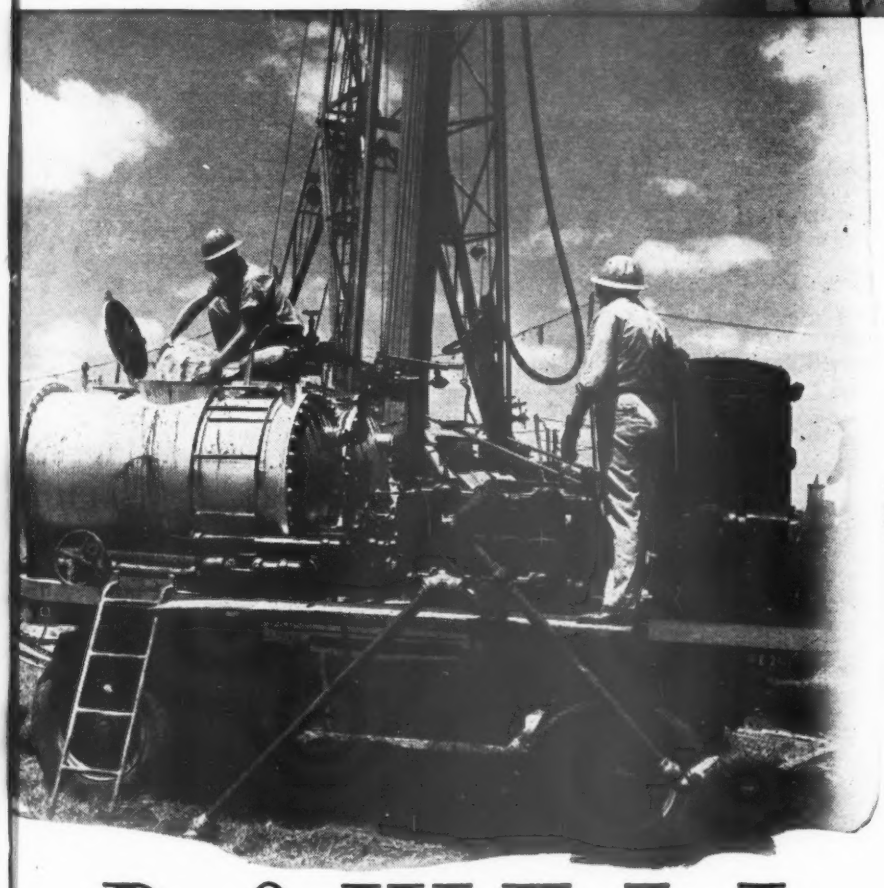
● **CANADA.** Imperial Oil Ltd. 1 Leduc, 16 mi south Edmonton, Alberta. Flowed 40 bbl/hr from 5029-66 ft.

*Production figures for day unless specified otherwise.

What's Below?

It's "what's below" that determines what remedial work may be necessary for better or more economical production.

DOWELL PLASTIC SERVICE solves many p[illegible]



Dowell Plastic Service has been used successfully for regulating water-oil and gas-oil ratios, consolidating sand, setting liners and casing, correcting faulty cement jobs, shutting off water in cable tool drilling, isolation squeezing, and in bridging operations.

Dowell engineers, using advanced equipment and techniques, have successfully demonstrated the excellent penetrating and bonding properties of Dowell plastic in literally *hundreds of wells* in many fields. Dowell plastic enters the well as a true fluid—then changes to an *impervious solid* at the proper time and place under the conditions found in the well. Best results are usually obtained when a Dowell Electric Pilot Survey has been made to determine the sources of water intrusion and to locate and evaluate the zones of permeability.

Call the nearest Dowell office or station for full information. Other Dowell services: Selective Acidizing, Mud Acid, Electric Pilot and Chemical Scale Removal from heat-exchange equipment. Dowell products: Paraffin Solvents, Jelflake, and Bulk Inhibited Hydrochloric Acid.

DOWELL

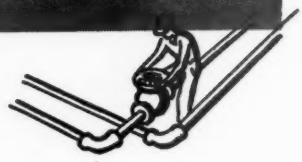
EAST TEXAS WATER SHUTOFF:
Well making 70% water. Dowell Water Locating Survey found water entry at 3163 and 3639 feet. Well was plugged back with plastic to 3626 feet. Subsequent production showed only 7% water. (Many other examples are available.)

DOWELL INCORPORATED • TULSA 3, OKLAHOMA
Subsidiary of The Dow Chemical Company

Look to

FOR OIL INDUSTRY CHEMICAL SERVICE

pipeline developments



● **ARABIAN LINE CONTRACTS.** Trans-Arabian Pipe Line Company has confirmed that orders have been placed with Consolidated Steel Company of Los Angeles for 930 miles of pipe and with National Tube Company of Pittsburgh, Pennsylvania, for 70 miles of pipe to be used in constructing the Trans-Arabian pipe line.

Contracts have also been awarded Chicago Bridge and Iron Company of Chicago for erecting 14 tanks, and Graver Tank and Manufacturing Company of East Chicago, Indiana, for erecting 22 tanks of an aggregate total capacity 5,700,000 bbl.

Contract was awarded to Bechtel Corporation of San Francisco and associates, including H. C. Price Company of Bartlesville, Oklahoma, for constructing about 600 miles main line and four pump stations at eastern end.

Williams Brothers Corporation of Tulsa was awarded contract for constructing approximately 450 miles of main line at western end and also Mediterranean tanker loading terminal. Graver was also awarded contract for constructing two intermediate pump stations at western end.

● **BIG INCH TO EXPAND.** Texas Eastern Transmission Company of Houston plans to spend $40,000,000 on the Big and Little Inch pipe lines for compressors and other equipment to increase the amount of natural gas moved from Texas fields to eastern consumers to 425,000,000 cu ft daily from 150,000,000 ft. George R. Brown of Houston, chairman of the board of the new company that bought the lines from the War Assets Administration, said the company hoped to take over operation by May 1.

The War Assets Administration has announced that the Humble Oil and Refining Company of Baytown, Texas, has bought government-owned facilities, which are on the company's property, for $93,000. The facilities include an office building, pipe lines and pumps.

● **HELIUM PIPE LINES.** Two government pipe lines in Texas and New Mexico, totaling 120 miles, carry helium for charging into high pressure tank cars. The helium is valued at $10 per thousand cubic feet.

● **BIDS ON PLANTATION LINE.** War Assets Administration announced that eight bids have been received and opened for the end part of the wartime-built Plantation pipe line, which runs between Greensboro, North Carolina, and Richmond, Virginia. Cost of the section was approximately $4,000,000. It extends 179 miles.

Keystone Pipe Line Co., Philadelphia, made the high bid, $477,000, for the line and all equipment. It submitted an alternative bid, however, of $125,000 for four pumping stations and all equipment required for these stations. Second high bid was submitted by the Plantation Pipe Line Company, Atlanta, the wartime operator, for $425,000.

Other bidders were: S. Bender, Shreveport, Louisiana, $300,000; Lipsett, Inc., New York, $150,000; M. N. Landay Co., Pittsburgh, $351,716; Williams Bros., Washington, $375,000.

● **PLAN RADIO CLEARANCE.** Plans have been made by a special oil industry radio committee to push proposals by Joseph Keller, National Petroleum Association, for special petroleum radio service to govern communication along rights-of-way of petroleum pipe lines. At a committee special meeting in Washington, under the chairmanship of James E. Moss, director of transportation, American Petroleum Institute, it was decided to recommend to API that a central permanent committee on radio petroleum facilities be set up and that clearance of activities be made through the transportation division.

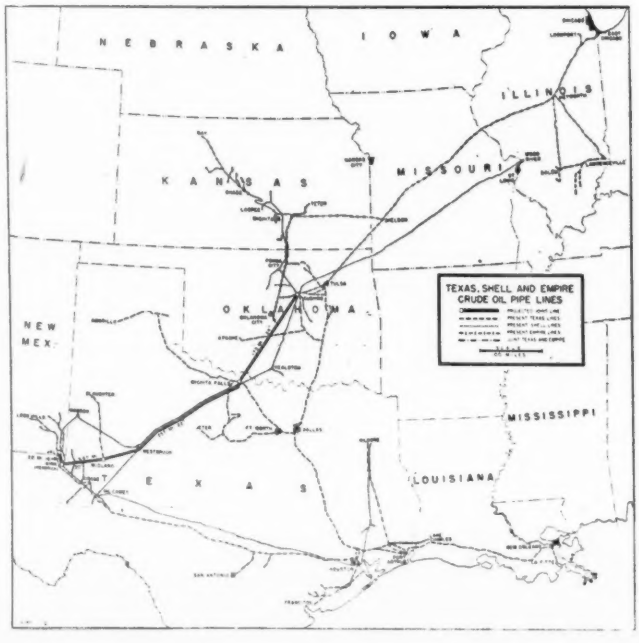
● **LINE EXTENDED.** Workmen are laying 95 miles of pipe to carry natural gas from Hidalgo County to Banquete in Nueces County, Texas, where it will feed into the trunk line of the Tennessee Gas and Transmission Company, which in turn will deliver the gas to the east through the Big Inch. The Hidalgo line connects at the San Salvador gas-condensate field, about 18 miles northeast of McAllen.

● **THREE FIRMS JOIN IN BIG CRUDE LINE.** Plans were revealed by The Texas Pipe Line Company and the Shell Pipe Line Corporation for construction of a 500-mile crude oil pipe line having a normal carrying capacity of 150,000 bbl daily and extending from the Permian Basin in West Texas and Southeast New Mexico to Cushing, Oklahoma. In making the joint announcement, T. E. Swigart, president of Shell Pipe Line Corporation, and R. B. McLaughlin, vice president and general manager of The Texas Pipe Line Company, stated that the projected carrier would be the largest U. S. crude oil line yet constructed with private capital.

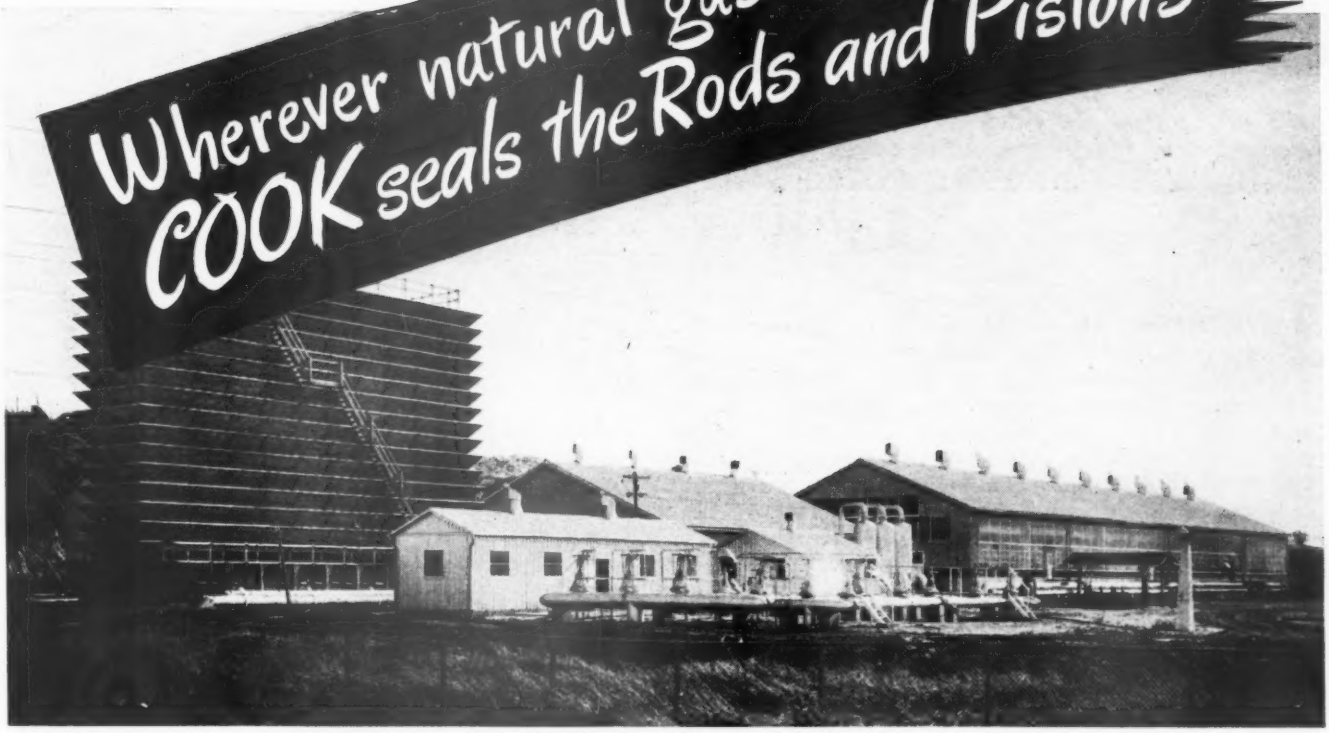
The line from Jal, New Mexico, to Midland, Texas, will be 22 in. in diameter and will extend 251 miles from Midland, via Westbrook, to Wichita Falls. The 24-in. segment will carry the increased load of crude 173 miles from Wichita Falls to Cushing.

Modern-type pumping stations will be built at Jal, Wink, Midland, and Wichita Falls. Present plans call for centrifugal pumps driven by either diesel engines or electric motors, depending upon the availability of equipment and power supplies. The erection of seventeen large steel storage tanks will commence in June, 1947. These tanks, of the latest design. were ordered especially for this project.

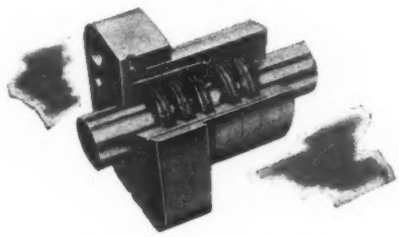
The line will be jointly owned, with The Texas Pipe Line Company owning 53 per cent, Shell Pipe Line Corporation 33⅓ per cent, and Empire Pipe Line Company (a subsidiary of Cities Service Company) 13⅔ per cent.



Wherever natural gas is compressed COOK seals the Rods and Pistons



COOK GRAPHITIC IRON PISTON RINGS are made of an exclusive material that imparts longer life and the ability to restrict cylinder wear.



COOK METALLIC ROD PACKINGS are fitted with metal rings that float in especially provided grooves to minimize friction and provide years of uninterrupted service.

Sealing Pressures

Since 1888

IT is not by accident that Cook Rod Packings and Piston Rings are in general use throughout the Natural Gas Industry. Rather, it is the result of a definite plan—a plan designed to give Cook customers the maximum in performance, first, last and all the time—through intensive research—the best in engineering—a field service organization to constantly check end performance.

Down the years this basic performance-insuring plan has been faithfully carried out. Proof positive of its success is provided by the following facts:

1. Over 90% of all gas engine driven compressors built during the past decade have been Cook equipped.
2. The major companies specify Cook products on orders for new equipment.
3. Compressor manufacturers give preference to Cook products.

In the performance of a trying war accomplishment Cook has learned as well as delivered. Today, Cook customers will find the basic plan has been greatly intensified so that every user of Cook products can count on the utmost in performance and operational savings.

C. LEE COOK MANUFACTURING CO.

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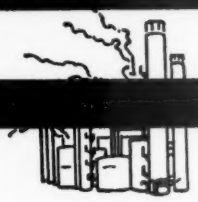
BALTIMORE • BOSTON • CHICAGO • CLEVELAND • HOUSTON • LOS ANGELES • MOBILE • NEW ORLEANS • NEW YORK • SAN FRANCISCO • TULSA

refining and natural gasoline activities



● **SYNTHETIC ALCOHOL UNIT.** Oil refinery wastes will soon be used to produce alcohol for the manufacture of a variety of products when the Shell Chemical Company completes a $2,200,000 synthetic ethyl alcohol plant, it was announced. Shell officials said the new plant on the Houston ship channel would have an annual output of about 18,000,000 gal. C. H. Braun and Company is the contractor.

It was stated that synthetic ethyl alcohol could be produced cheaper from petroleum by-products than grain alcohol. The synthetic alcohol will be manufactured from refinery waste gases.

The actual laboratory work on the new discovery was done in Emeryville, California, with supervision from the Houston Shell plant. The synthetic ethyl alcohol will be used in perfumes, drugs, liquor, and other products. Shell officials said their entire production for the next three years has been contracted for. Plant is expected to be completed by October.

● **PURE TO EXPAND PLANT.** The Pure Oil Company announced that it plans a $9,000,000 expansion for its Smith's Bluff plant, near Nederland, Jefferson County, Texas.

The expansion is designed to replace facilities destroyed by fire at Marcus Hook on the Atlantic seaboard, it was said.

Permits issued by the Civilian Production Administration allow construction of buildings for manufacture of soap greases, high pressure lubricants, sulphurized cutting oils.

● **CYCLOTRON OIL MADE.** Gulf Oil Corporation announced the development of "cyclotron oil," designed to withstand the catalytic action of the large amounts of copper used in cyclotron production of radioactive elements. Initial application of the new oil is being made in the just-completed cyclotron of the University of Pittsburgh.

● **NEW MOLECULAR ACTION.** A molecular still, so powerful it can "distill" solids and liquids never before vaporized, is being used to explore the mysteries of what constitutes petroleum, Gulf research laboratories, which pioneered the development, have revealed. The still creates an "effectively perfect" vacuum, nearest thing to absolute vacuum known to man, under conditions of less than one billionth of atmospheric pressure.

In this zero atmosphere, solids as well as liquids can be evaporated into their various molecular components. Oils, greases and waxes divide into several hundred parts, with a degree of separation never before approached. The segments obtained are analyzed for viscosity, viscosity change with temperature, stability and other fundamental properties. These studies guide selection of crude oils and refining methods toward production of improved petroleum products.

● **BIDS ON OLD OCEAN REFINERY.** Three companies have made bids on the J. S. Abercrombie and Harrison Oil Company refinery at Old Ocean, Texas, put up for sale by War Assets Administration. They were: Stanolind Oil and Gas Company, Tulsa, $7,000,000 cash; Premier Oil and Refining and Sklar Oil Company of Texas, joint bid, $1,000,150 cash, and Clayton N. Smith, Houston independent, rental of property for 5 years on production scale basis with option to purchase for $13,500,000 at end of period.

● **EXPAND PLANTS.** Wood River Oil and Refining Company is building cycloversion unit at its Hartford, Illinois, plant. It will crack 5000 bbl of gas oil, desulphurize and reform 8000 bbl straightrun gasoline or 10,000 bbl thermally cracked gasoline.

El Paso refinery of Standard Oil Company of Texas has a $3,000,000 expansion program under way. Storge tanks, a new distillation unit, and laboratory are scheduled among other improvements.

● **CONTRACT AWARDED.** Work has begun on the change of catalyst and case repair on the four-case Houdry fixed-bed cat cracker at Socony-Vacuum's East Chicago, Indiana, refinery, it has been announced. Contract for the work has been awarded to Catalytic Construction Company, which will complete similar work at Socony-Vacuum's Paulsboro plant, approximately March 15.

● **SYNTHETICS GETTING CHEAPER.** "At the present rate of research progress, production of synthetic petroleum products on a commercial basis is possible within a few years," Dr. R. R. Sayers, director of the Bureau of Mines, announced.

The cost of producing gasoline from coal or oil shale will range from 7.5 to 9.5 cents a gallon, he said. This is a few cents higher than the current production cost of gasoline from petroleum, according to the Interior Department's annual report to Congress. This estimate, however, does not include profit or interest on investments.

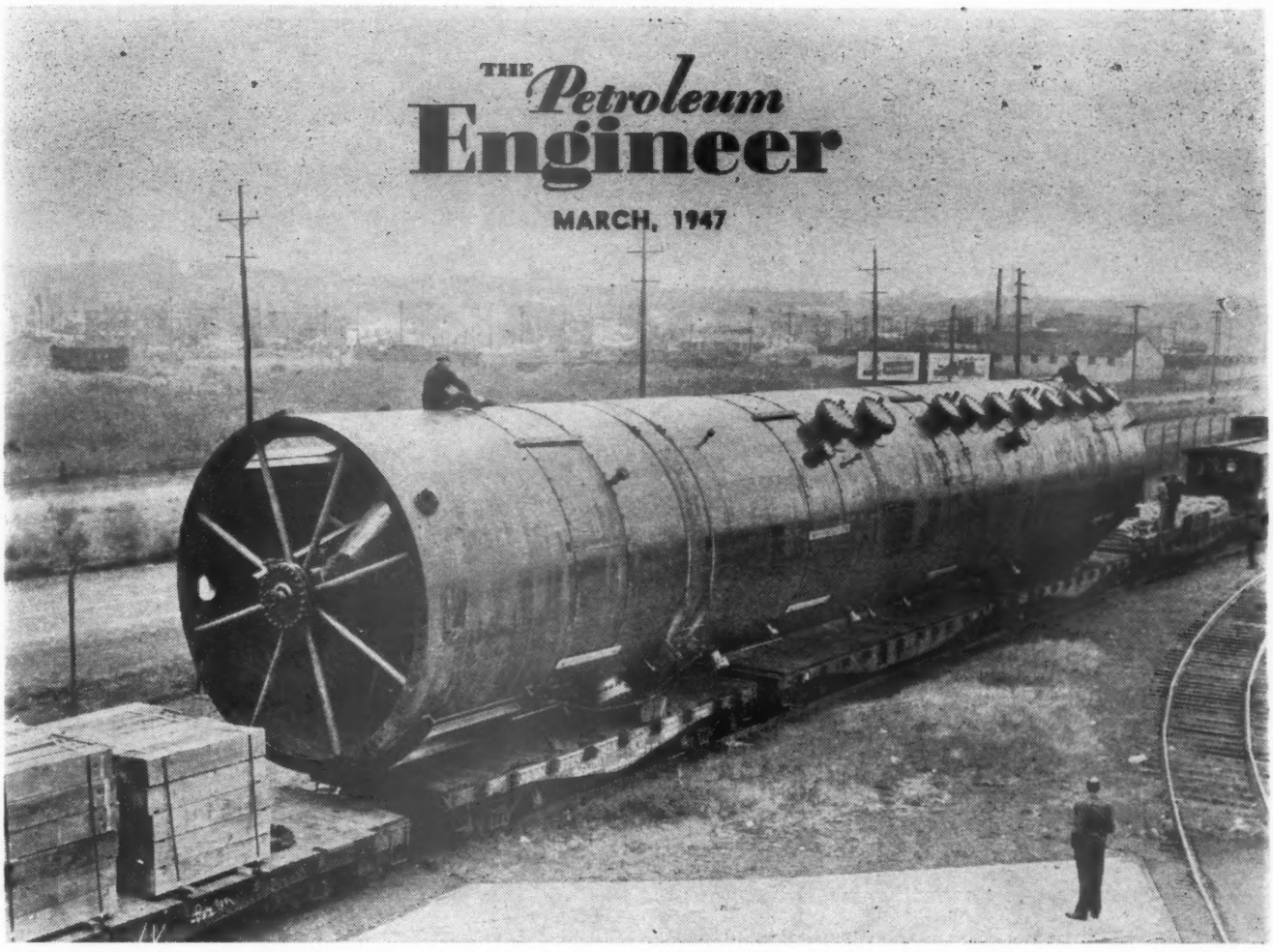
The Bureau of Mines is operating several research plants to develop a cheap synthetic gasoline product from coal and oil shale. They are at Pittsburgh and Bruceton, Pennsylvania, Louisiana, Missouri, Morgantown, West Virginia, Gorgas, Alabama, Laramie, Wyoming, and Rifle, Colorado.

● **FORM NEW FIRM.** Richfield Oil Corporation will manufacture all petroleum products to be marketed by the newly-formed American Mineral Spirits Company, Western, according to announcement by American Mineral Spirits Company of Chicago, joint owner of the new firm with Richfield. The parent American Mineral firm has specialized for many years in the manufacture and marketing of petroleum solvents or technical naphthas east of the Rockies.

President of the new concern is Max A. Williams, vice president of the Chicago firm, while David E. Day, vice president in charge of manufacturing for Richfield, is executive vice president. Home offices are in Los Angeles.

● **PLANTS CHANGE OWNERS.** Oil Marketing and Refining Company, Inc., has sold its Salem, Nebraska, refinery to Searle Petroleum Company of Omaha. H. A. Searle, Jr., president of Searle Petroleum, states that the purchase will double the company's present refining capacity and the purchase also includes additional crude and tank cars for the Searle interests. New production will be sought and will involve possible increase of Nebraska crude oil output through test wells in new territory including exploration of deeper horizons.

Calumet Refining Company has acquired the assets of the Princeton Refining Corporation, Princeton, Louisiana, according to announcement by C. A. Harris, general manager. Operations will be resumed this month, after improvements and repairs, now in progress, are completed. Further modernization will take place later this year. The plan will produce lubricating oils from selected crudes. Calumet also has a refinery at Burnham, Illinois, headquarters and a warehouse and compounding plant in Chicago, and a branch office and compounding plant in Cleveland, Ohio.



Big tower towed from Jersey to Missouri

A HUGE fractionating tower was constructed last fall as part of the catalytic cracking plant at the Sugar Creek, Missouri, refinery of the Standard Oil Company of Indiana. It was completed by the M. W. Kellogg Company at its Jersey City works and was far away from its final destination, nine miles east of Kansas City.

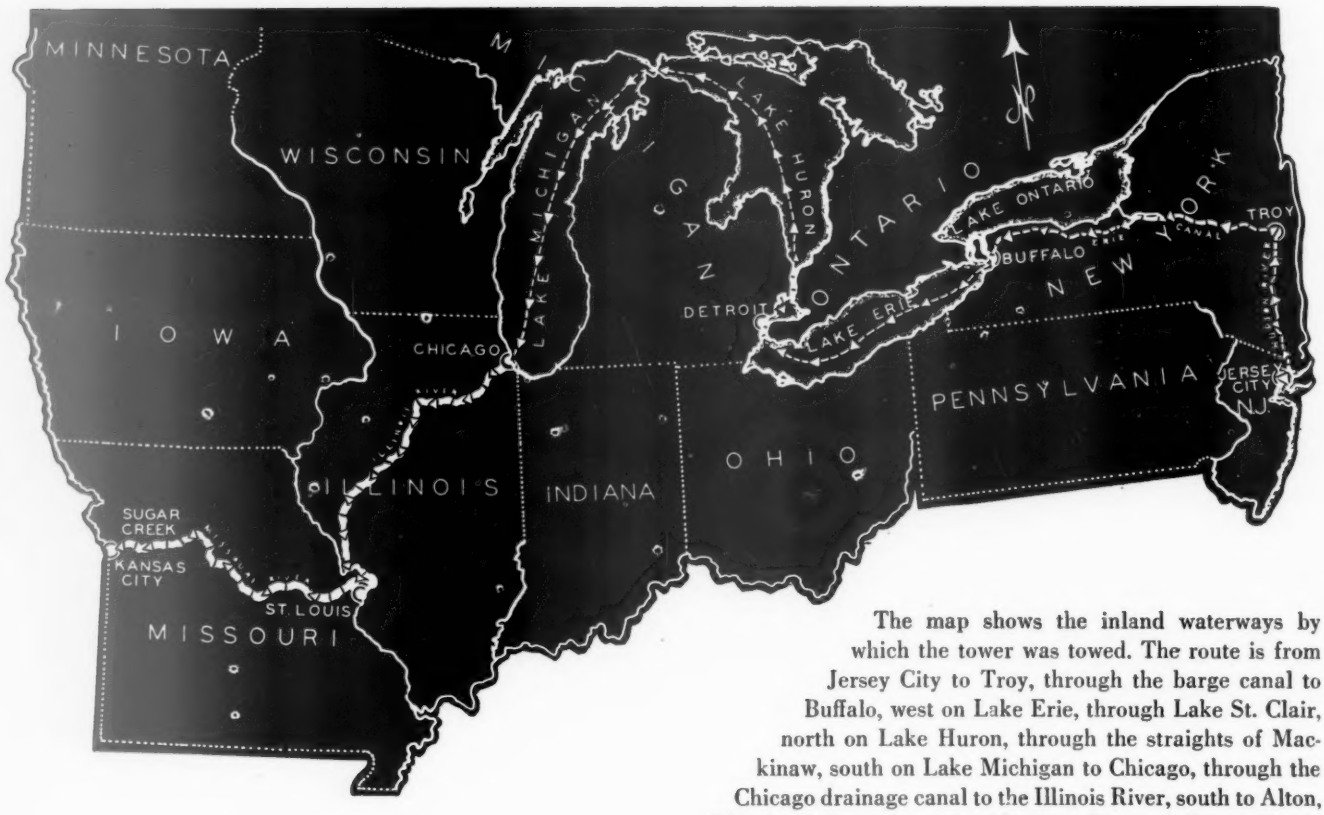
It was the task of George O. Headen, manager of Kellogg's traffic department, to deliver the tower to the refinery, and to have it there on time so as not to delay completion of the cracking plant. The tower, made to handle 20,000 bbl of oil a day, is 117 ft long by 16 ft diam and weighs 165 tons. It has a thickness of only $\frac{7}{8}$ in., but is lined with $\frac{1}{2}$-in. stainless steel. Consequently, it had to be handled with great care, especially to insure that no damage resulted to the projecting bosses and flanges during the trip.

Decision was made to float the tower via the Hudson River and then along the nearly 2000 miles of other inland waterways. For this work a towboat company well experienced in similar hauling, the Moran Towing and Transportation Company, was given the contract. The Moran company selected a tug powered with a General Motors diesel engine. There were no involuntary engine stoppages on the 1600-mile voyage to Chicago, which was as far as the draft of the tug would allow her to go.

There a river tug under Moran direction took over and hauled the tow through the Illinois waterway to Seneca, Illinois. There the tower was taken out of the water and loaded on a barge, as there was insufficient water in the upper reaches of the Missouri to handle the 7½-ft draft. The barge had a length of 195 ft by 35 ft beam, and drew 3 ft 8 in. of water. The tow continued along the Illinois waterway to Grange, Illinois, then up the big river 375 miles to Sugar Creek, where the tower was unloaded in excellent condition at the Indiana Standard's refinery.

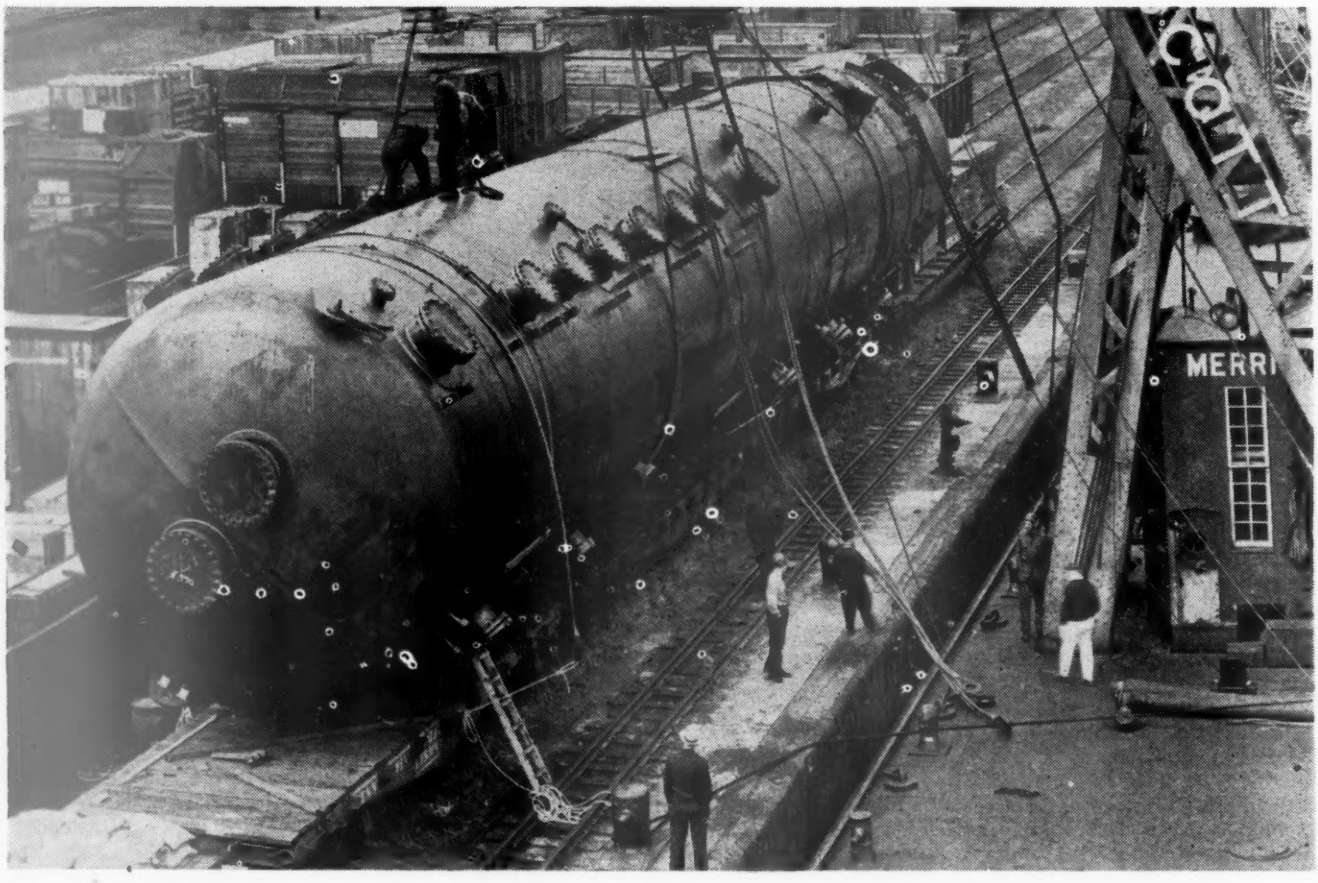
The illustration above shows the tower as it left the Kellogg plant in Jersey City. It was moved by rail on three flat cars a distance of two and one-half miles to the waterfront.

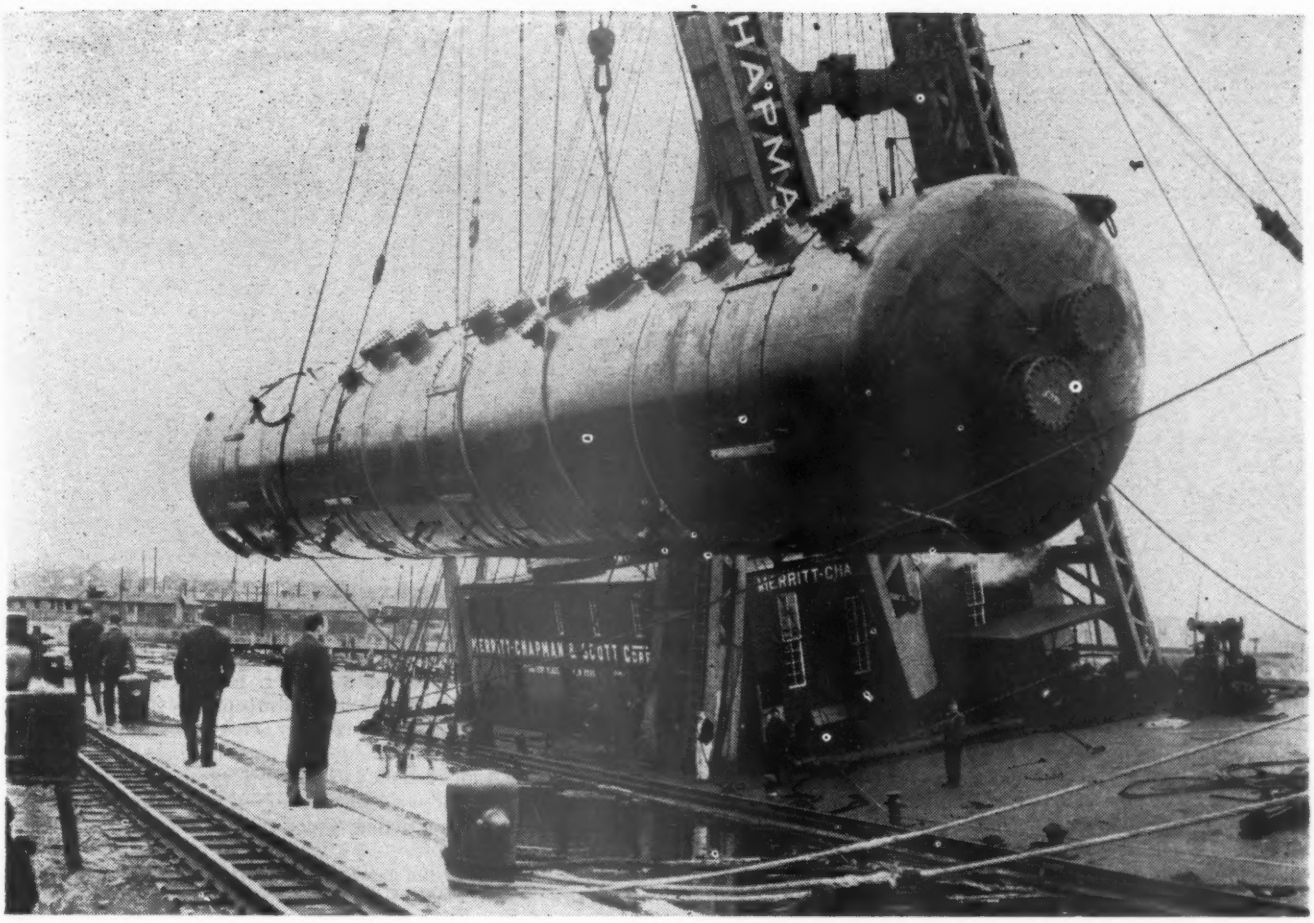
Modern great refinery towers have presented special problems in transportation for some time. Railways often have bridges or overpasses too small to allow passage of the huge cylinders. Last year a fractionating tower built in Milwaukee for a Whiting, Indiana, plant was also transported by flatcar and over Lake Michigan by barge and tug. *(The Petroleum Engineer, Sept., 1945, p. 55)*



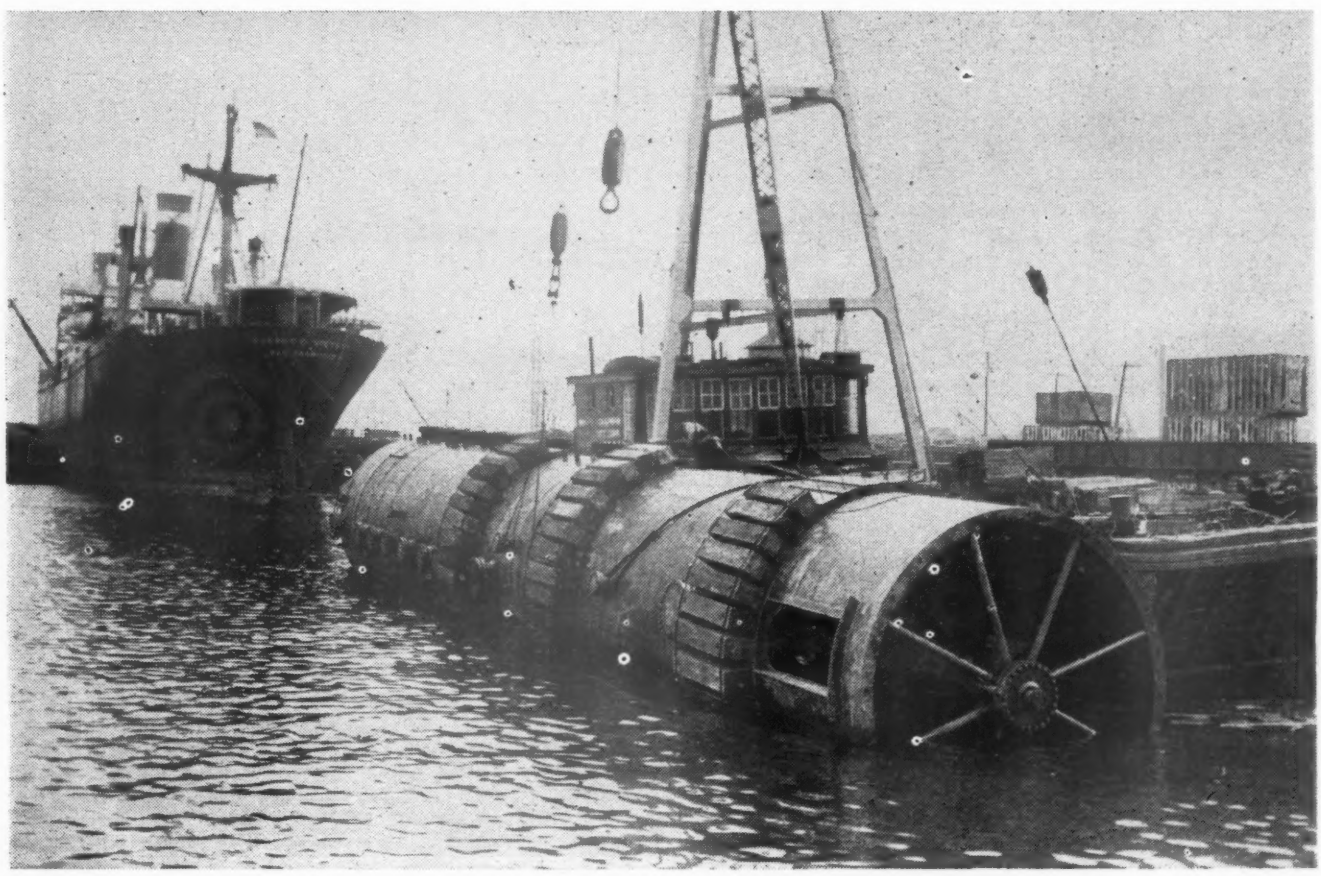
The map shows the inland waterways by which the tower was towed. The route is from Jersey City to Troy, through the barge canal to Buffalo, west on Lake Erie, through Lake St. Clair, north on Lake Huron, through the straights of Mackinaw, south on Lake Michigan to Chicago, through the Chicago drainage canal to the Illinois River, south to Alton, Illinois, then west on the Missouri River to Sugar Creek.

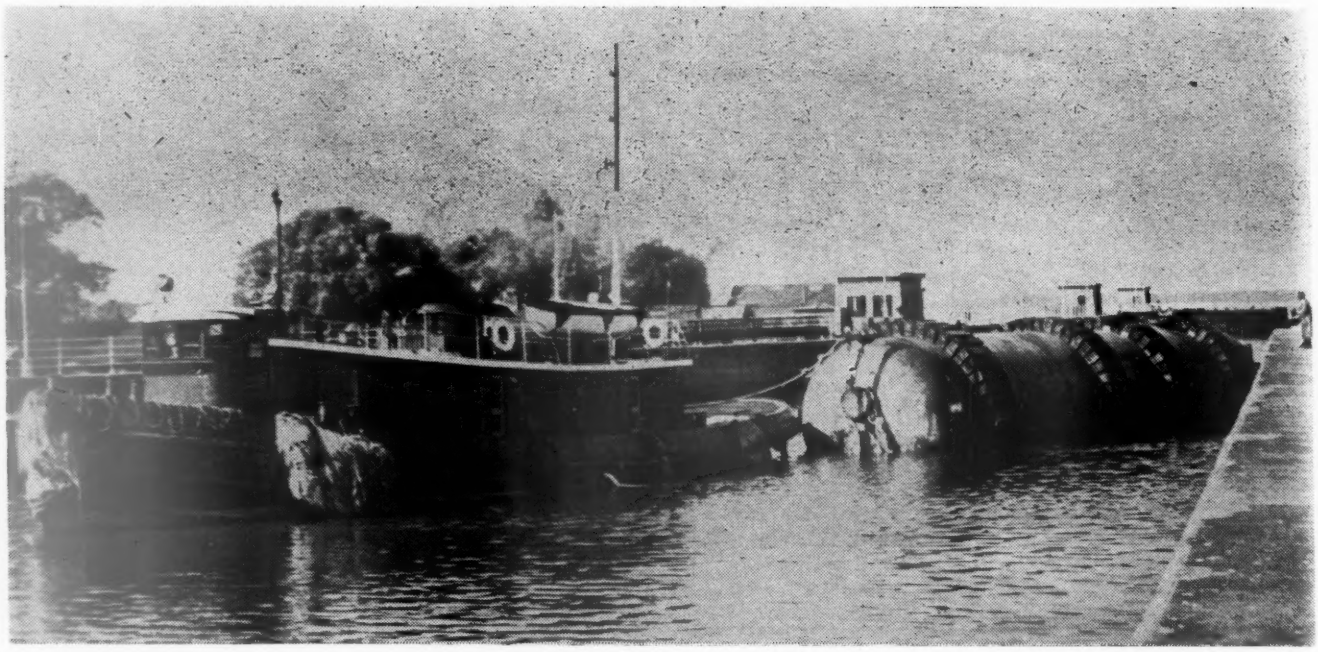
Refinery tower arrives by rail at the Claremont Terminal Jersey City. Crane barge alongside dock is preparing to lower tower into the water at the beginning of the long tow to Missouri.





The tower was lifted up by the crane and lowered into the water at Claremont Terminal. In the water, below, two days were required to lag and ballast the structure. Lagging was four sets of large wooden slats placed around the tower for protection.



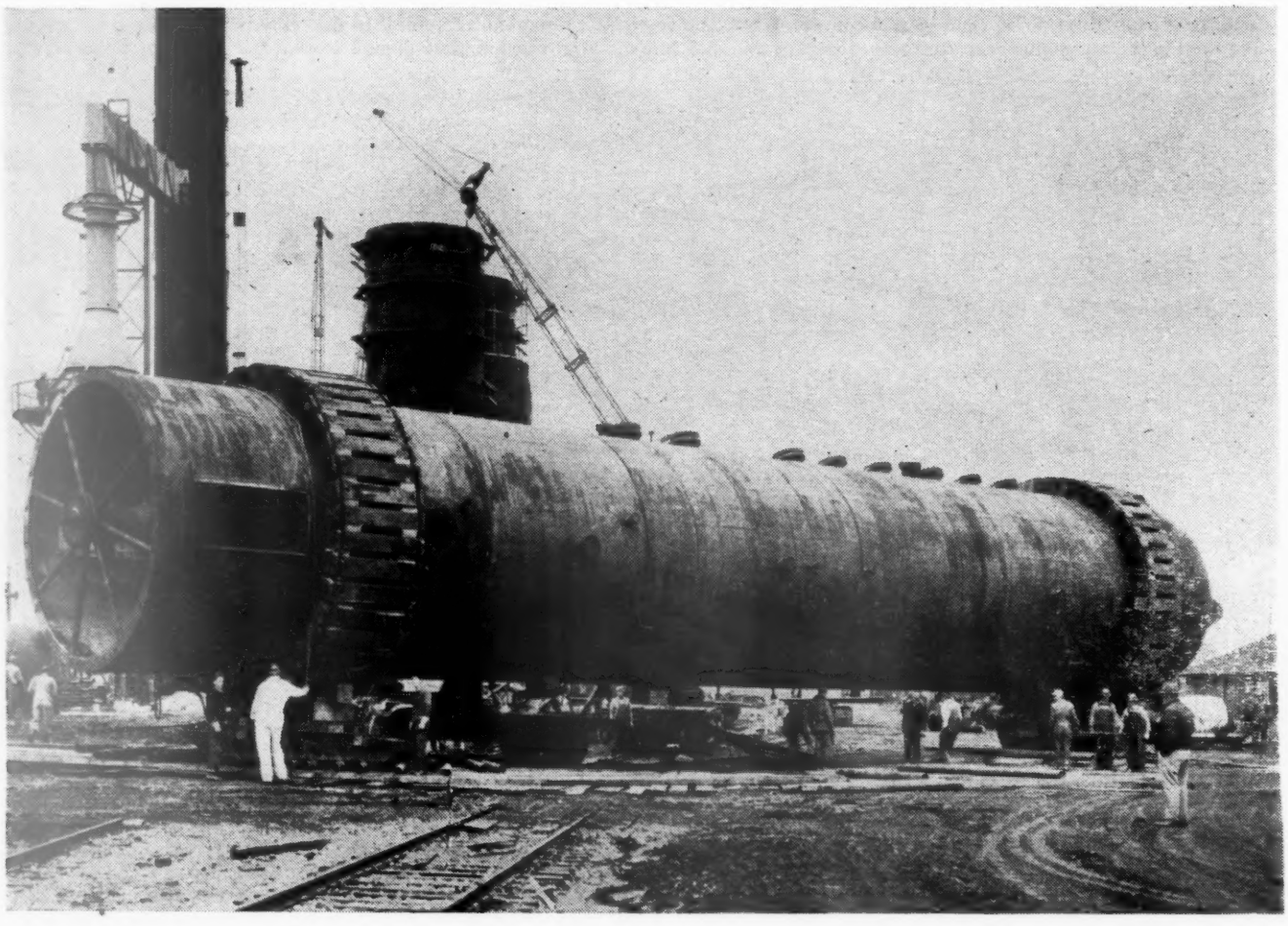


Tug and tower are shown in the government lock at Buffalo above. The ballasting prevents rolling, although the tower pitched and yawed in rough water such as was met on the Great Lakes. There was no ice, however.

Ballasting was arranged by loading 40 tons of sand into bags, but only half filling each bag, which virtually makes them immovable and prevents shifting in rough weather. Carefully trimming the ballast brought the tower down by the stern a little, which improved its following capability under tow, and this feature was aided by the skirt of the tower that projected aft of the rear lagging, acting as a rudder. In towing condition the tower weighed 200 tons, and had a draft of 7½ ft.

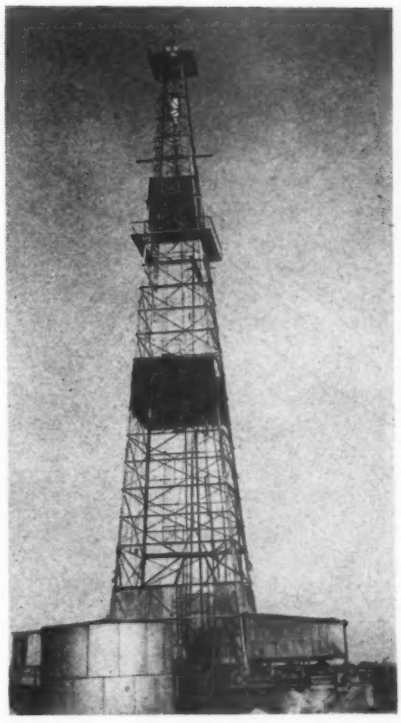
The total distance to the refinery, covered without incident, was 2025 miles and took 32 days. The sturdy little tug that made the long haul is an 86-footer of the DPC type, powered with an 8-cylinder 700-hp General Motors diesel at 750 rpm, with airflex coupling and reduction gear, and is constructed with a steel hull.

Below, the tower has arrived at Sugar Creek refinery and is being prepared for erection. ★ ★ ★



Deepest well in the world is drilling below 17,000 ft.

By **K. MARSHALL FAGIN,** *Field Editor*



World's deepest well has one of world's highest derricks, 176 ft, and two monkey boards. Bolted steel tank contains reserve drilling mud.

As this story is being written, Superior Oil Company's Weller No. 55-11 well in Caddo County, Oklahoma, is drilling ahead at a total depth of 17,008 ft with a 3-cone rock bit, 218 ft of 4½-in. by 1½-in. drill collars, and a combination string of 3½-in. by 13.30-lb and 15.50-lb, grade E, range 3, external upset drill pipe.

EXCLUSIVE

Drilling progress at this depth has dropped to about 12 ft per day. This is partly due to the nature of the formation being drilled and the care being exercised to prevent a twist-off or other trouble, but round trip home at this depth takes at least 6 hr and the footage from the bits is frequently less than 6 ft.

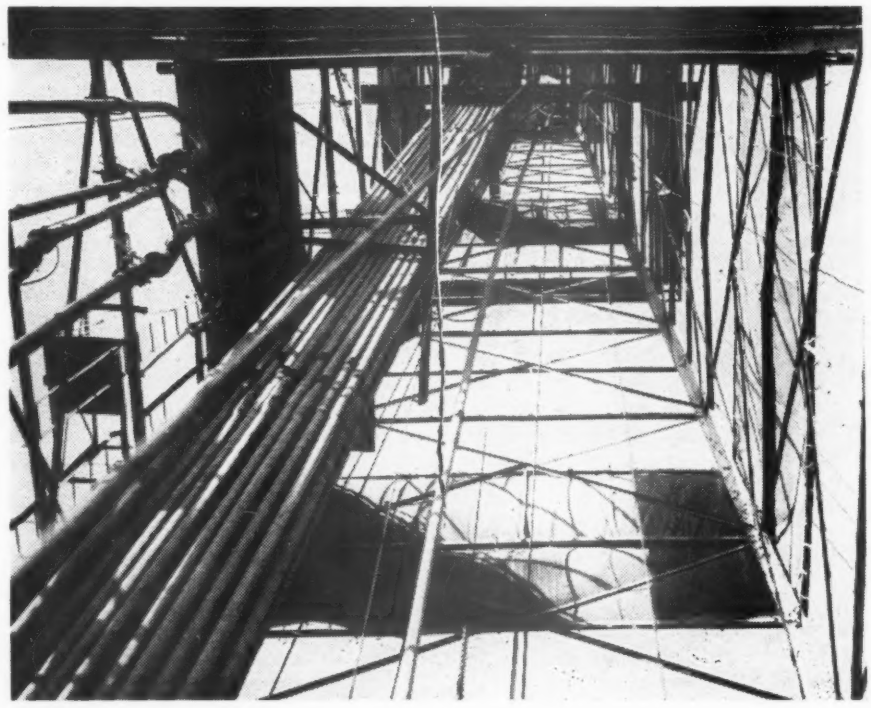
The drill stem is turned slowly at the rate of 20 to 30 rpm, and not more than 10,000 to 15,000 lb weight is put on the 5¾-in. rock bit. Three mud pumps are available for circulating the water-base drilling fluid, but one duplex 18-in. by 6½-in. by 20-in. stroke pump operating at 25 to 35 spm supplies sufficient volume at 1500 to 1600 psi pressure to remove the cuttings at the present depth.

● **Well was spudded in April, 1946.** About 11 months have been spent in drilling, coring, casing, testing, and fishing operations on this well. Neither of the two fishing jobs, however, delayed drilling operations a great deal, because the fish were quickly engaged and pulled from the hole. In one case, part of a string of 4½-in. drill pipe became unscrewed and dropped to the bottom of the hole, and in the other case, two drill collars were left on bottom. Both of these accidents occurred at relatively shallow depths in the early stages of drilling. Coring and testing operations account for part of the elapsed time, but the exact amount consumed in these operations is not available at this time.

An intermediate string of 9⅝-in. casing was set at 10,200 ft with 1000 sacks of cement. About 5000 ft of this string was 54-lb pipe, and the rest was 47-lb pipe.

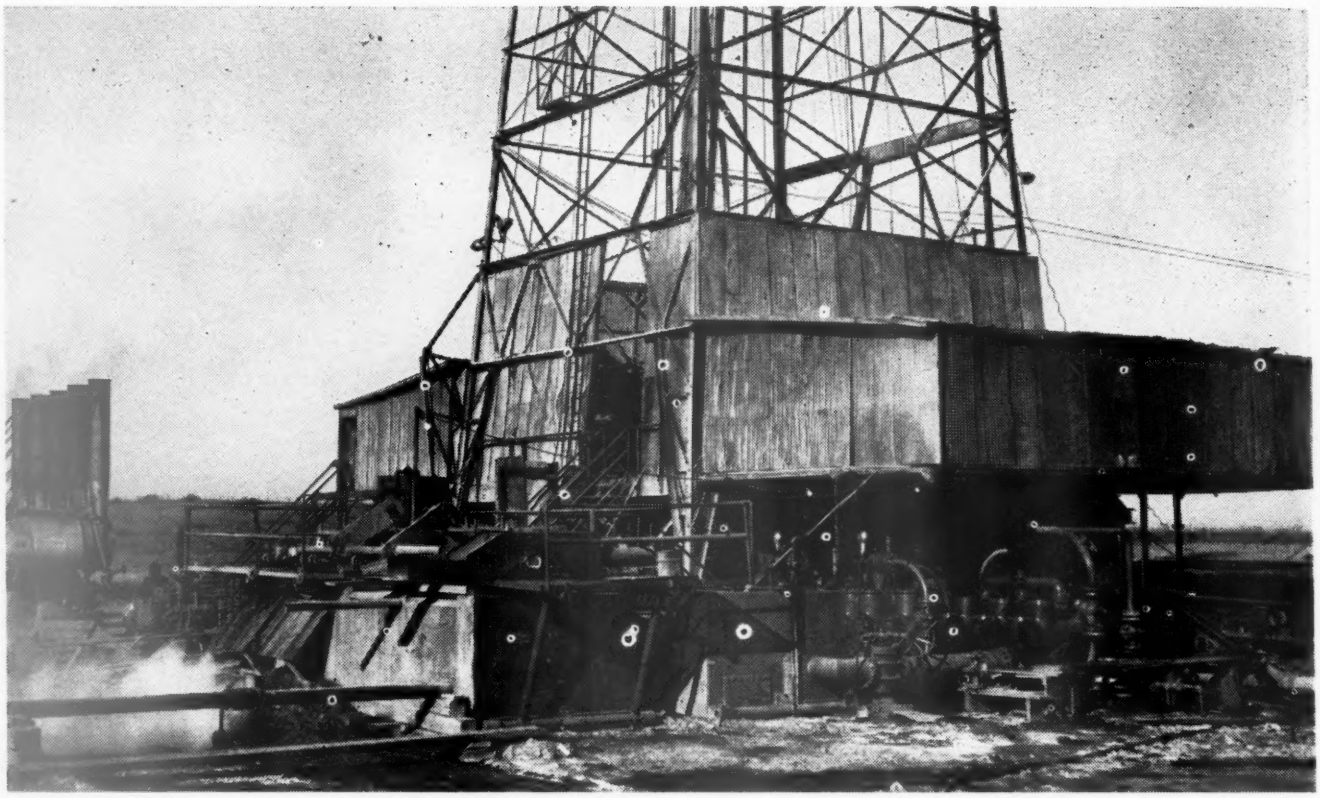
The world's longest string of 7-in. casing was run into the well and landed at 16,351 ft in about 27 hr on January 1 and 2, 1947. It was a combination string of 39-lb and 36-lb per ft, grade N-80, range 3, extreme line casing. The string was run slowly and carefully under the supervision of John Cody, Superior's vice president in charge of production, Pacific Division. Each joint was thoroughly cleaned, inspected, and regreased before running into the well. All joints were shouldered uniformly with five to six wraps on the cathead and three to five jerks with the tongs. Each length of pipe was checked with a 0.0015-in. feeler gauge for shoulder make-up The string was cemented with 1000 sacks of slow setting cement. The temperature at 16,351 ft in this well is about 350 F.

Derrick man on top monkey board has just fastened elevators around a stand of drill pipe that will be connected and run into well. Derrick man on midway monkey board is selecting next stand to be run and is hidden by rack of drill pipe stands.



● **Rig equipment and arrangement.** Although this well, which is situated in the Anadarko basin of west central Oklahoma about 6 miles north of the town of Ft. Cobb, is the deepest one in the world, it was not drilled with all the latest and most powerful equipment that is manufactured. This is simply another way of saying that modern heavy drilling equipment is capable of drilling wells deeper than this one provided the drilling techniques are suitable to the natural problems that arise, and that abnormal pressures and heaving shale difficulties can be overcome by mud conditioning.

As shown by the accompanying illustrations, the drilling rig is supplied with steam by five boilers. These are rated at 225 hp and operate at 350 psi working pressure. They are fired with a combination of oil and gas. Water is obtained from three water wells spaced about 200 ft apart around the drilling site. Each well is pumped with a small unit and 4-cylinder gas engine from a depth of



Skid-mounted steel mud tanks with shale shakers atop outboard tank and triplex mud pump suction connection on inboard tank; five boiler stacks and duplex mud pump, left foreground, steel tank for mixing and feeding chemicals, behind shakers.

about 210 ft. The water is stored in two 1000-bbl bolted steel tanks, and is satisfactory for drilling and steam generation after being aerated.

The boilers are equipped with automatic feed water level controls and low water alarms. The feed water pumps are unitized on steel skids, and are situated in front of the boilers with the skid-mounted 10-kw turbo-generators that supply electricity for lighting, operation of the electric motors on the shale shakers, and the electric brake. An auxiliary electric generator driven by a gas engine is mounted on skids near change house.

● **Under-floor drive for rotary table.** The rotary table is operated by a duplex 12-in. by 12-in. steam engine, which is mounted on skids underneath the derrick floor. As shown by the accompanying photographs, the chain drive from the engine to the rotary is covered with an oil-bath chain guard.

The heavy duty drawworks, which has a 9-in. diam line shaft, is powered by a 14-in. by 14-in. twin-cylinder steam engine with a roller bearing shaft. A standby drawworks and steam drilling engine is mounted on the opposite side of the derrick floor for auxiliary or emergency hoisting service.

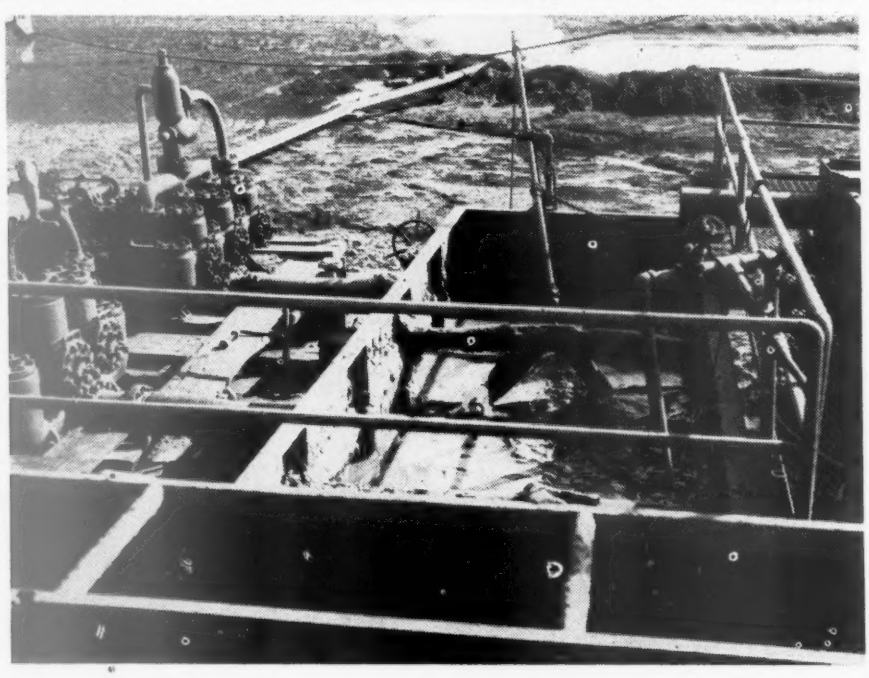
The main drawworks is equipped with an electric brake that has five sets of control resistances. At the present depth, the brake seems to operate best when it is set in the fourth position, and the long string of drill pipe can be set down on the slips without using the regular friction brake to an appreciable extent.

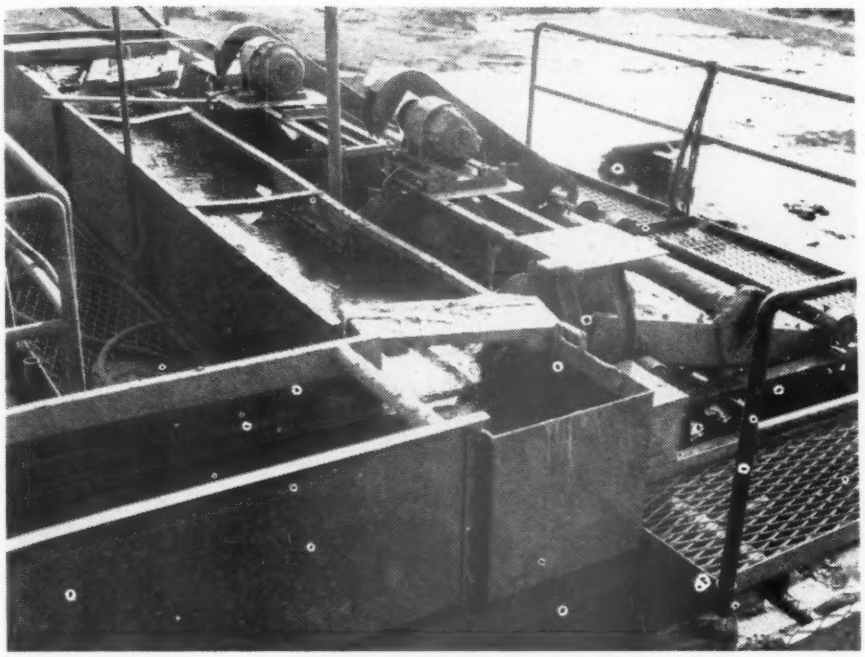
The fifth set of resistances tends to slow down the descent of the pipe too much as it is being run into the hole. Electricity for the operation of the electric brake is supplied by the steam turbo-generators or by the auxiliary gas engine driven generator mentioned previously.

The use of an electric brake on this deep well is evidence of the care that has been exercised in avoiding trouble due to the weight of the drill stem. It is obvious that in a well of this depth that nothing should be left to chance.

● **Drilling mud circulating system.** The drilling mud flows through an elevated steel flume, or possum belly, from the well to the two electric motor driven shale shakers, which are mounted on top of the outboard steel mud tank. A

Drilling mud flows from well (left) through steel flume (foreground) to shake shakers (right). Mud fills outboard tank (under shakers, right) and flows into inboard tank (center) where it is agitated before being picked up by mud pumps (left)





Bolted construction of steel mud flume (foreground) shown as mud spreads out to left in flowing over double-table shale shakers mounted on top outboard mud tank. Shale is shaked over tank edge and mud flows through screens on tables into tank.

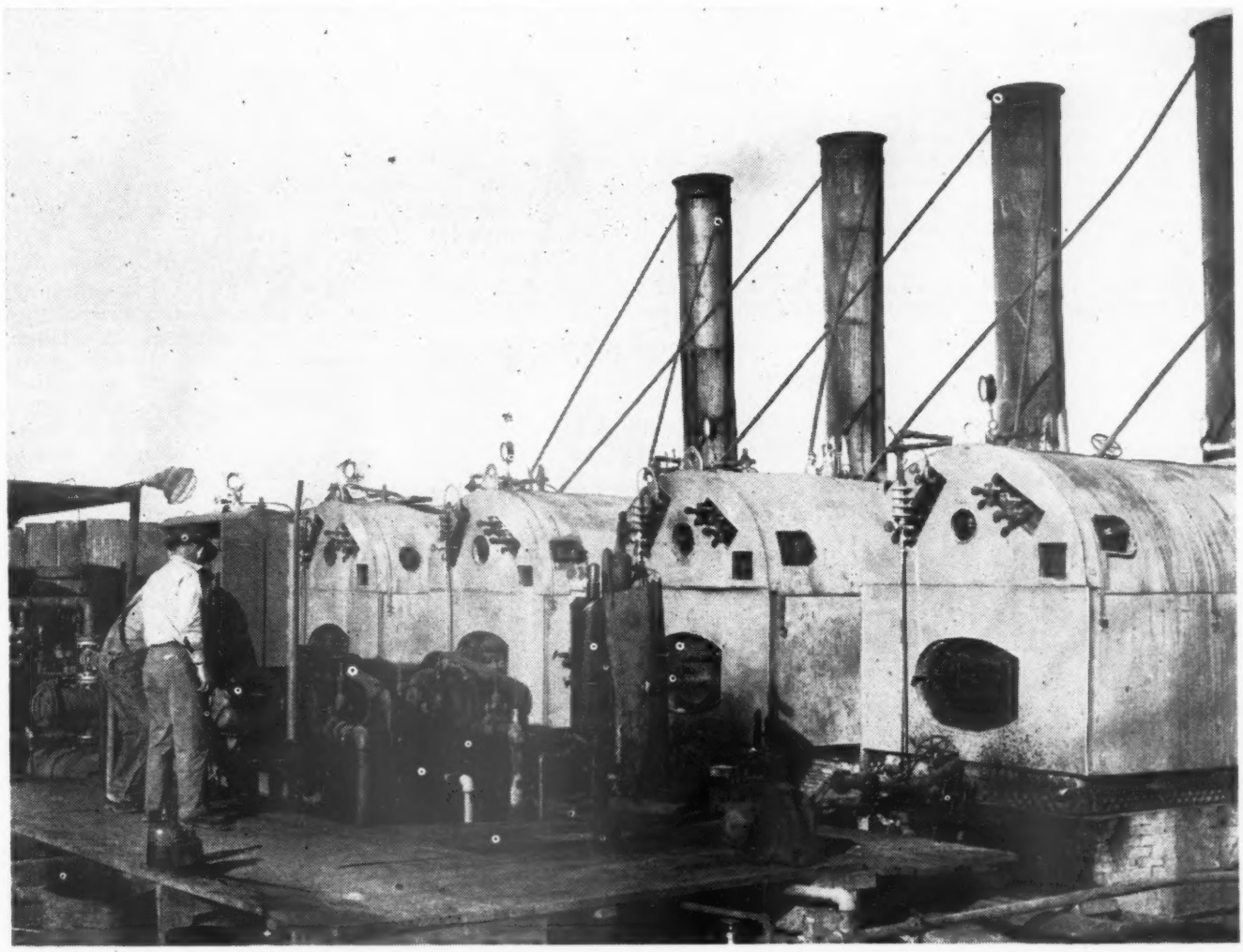
steel tank mounted on a platform beside the elevated steel flume is used to mix chemicals for addition by gravity feed to the mud as it flows toward the shakers.

After the mud settles in the outboard mud tank, it overflows into the inboard steel tank where it is thoroughly mixed with a mud jet gun. The steel mud tanks are about 16 ft long, 7 ft wide, and 4½ ft deep with a capacity of 90 bbl. They are mounted on steel skids for additional structural strength and ease of portability. The shale shakers are of the double table type.

The drilling mud is picked up from the inboard tank by the mud pumps and returned through the gooseneck, rotary hose, and swivel into the well. As shown in the pictures, the well is equipped with a standby gooseneck and rotary hose as an extra safety precaution.

A special back pressure valve is placed in the drill pipe just above the drill collars to prevent the drilling mud from overflowing the top of the drill stem as it is run into the well. The brass flap of this valve is kept closed by a small steel spring and the pressure from below, but the mud can move slowly upward into the drill stem through two ¼-in. steel choke jets that are pressed in the flap. The flap opens downward when the mud pumps are started, and the valve opening is large enough to prevent any restriction of circulation.

Battery of boilers have brick wall type of firebox foundation and valves for regulating mixture of fuel oil and gas that is used to fire them (right foreground). Layman Corley, drilling superintendent, and boiler fireman adjust panel connections.

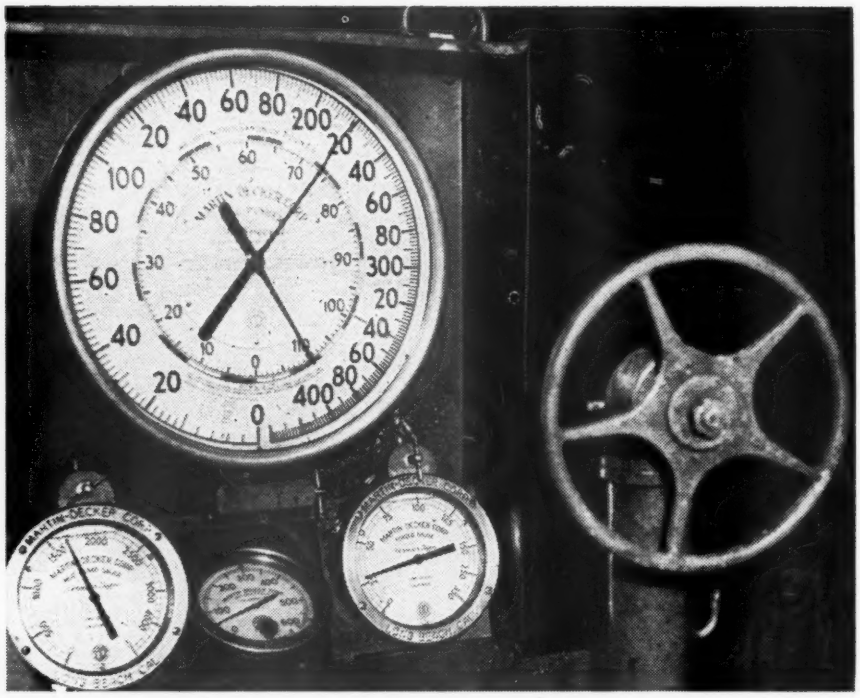


The three mud pumps are installed under the engine house floor near the inboard mud tank. Each one is mounted on steel skids. One of the pumps is a triplex and two are 18-in. by 6½-in. by 20-in. stroke duplex steam pumps. Another skid-mounted duplex steam pump is used for mixing and transferring drilling mud. A 1000-bbl bolted steel tank is used for storing a reserve supply of mud. At the present depth, the well is equipped with three blowout preventers.

● **Tall derrick has two monkey boards.** The main reason why the round trip time at the present depth is only 6 hr is the use of a 176-ft derrick with a 32-ft by 32-ft base. This allows the use of 42-ft lengths of drill pipe that can be pulled in thribbles about 130 ft long. Such high stands are difficult for one man to handle easily in the derrick, especially when the wind is blowing, so provision was made for a midway monkey board, or derrick man's working platform.

The blocks are strung with eight 1¼-in. wire lines to handle the full string of pipe and tools, which has a net weight in the hole of about 228,000 lb, or 114 tons. The steel substructures under the derrick and engine houses are about 11¼ ft high and are designed not only to carry the heaviest loads, but also for easy dismantling and portability.

A 7-sheave 600-ton capacity crown block is used in conjunction with a 6-sheave 500-ton capacity traveling block and 1¼-in. wire line to handle the drill stem. A geolograph wired to the swivel records the up and down movement of the kelly as it is pulled to make a connection and returned to drilling. The progress of the drill is thus traced by a pen in this instrument on a strip of paper that is turned by a clock. The counterweight for the geolograph moves up and down on one of the derrick guy wires.



View of driller's control panel shows large dial that indicates weight of drill-stem in thousands of pounds. Lower left dial indicates mud pressure of 1600 lb; center dial is tachometer showing rpm of rotary table; dial at right is torque gauge. Wheel on right regulates speed of underfloor rotary-drive engine.

The driller's instrument panel contains a weight indicator gauge, a mud pump pressure gauge, a rotary table tachometer, and a rotary table torque gauge indicator that reflects the steam pressure at the intake of the steam engine that drives the rotary table.

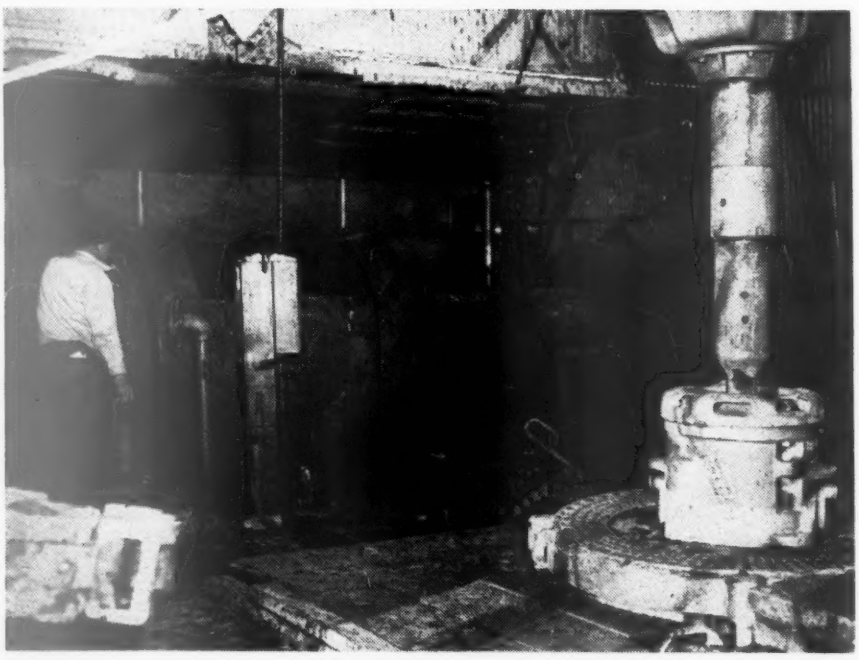
● **Drilling mud treatment.** Although drilling mud problems have arisen during the drilling of this well, loss of circulation or the other problems have not been serious. Barites, phosphates, and tannic acid have been used to keep the mud in condition. At present the mud weighs about 13.3 per gal, or 100 lb per cu ft; the marsh funnel vicosity is 60 to 70 sec; the water loss is about 10 cc per hr, or 5 cc in 15 min; the initial gel is 10 min; and the final gel is 80 to 100 min as measured with a Stormer viscosimeter.

● **Experience gained in deep drilling.** Whether or not this particular test well discovers oil or gas in commercial quantity at this record-breaking depth remains to be seen, but the deeper the well is drilled the greater is the experience gained in mechanical and practical problems in drilling for oil at greater depths, and a good many oil men, including geologists and engineers, believe that great quantities of hydrocarbons will ultimately be produced from depths of 15,000 to 20,000 ft beneath the surface.

The practical problem, and an important economical one, involves the further development of drilling technique that will result in reducing costs, and the only way to develop the technique is to pioneer in the drilling of deep wells as the Superior Oil Company and other are doing.

The drilling of this well is under the direct supervision of Layman Corley, drilling superintendent at Ft. Cobb, Oklahoma. An assistant drilling superintendent, a petroleum engineer, and four crews of seven men each are employed in the operation. ★ ★ ★

Drilling ahead just before making a connection at 16,970 ft. Square portion of the Kelly has disappeared into drive bushing. Control panel is in front of the driller.



Smokeless burning of refinery vent gases

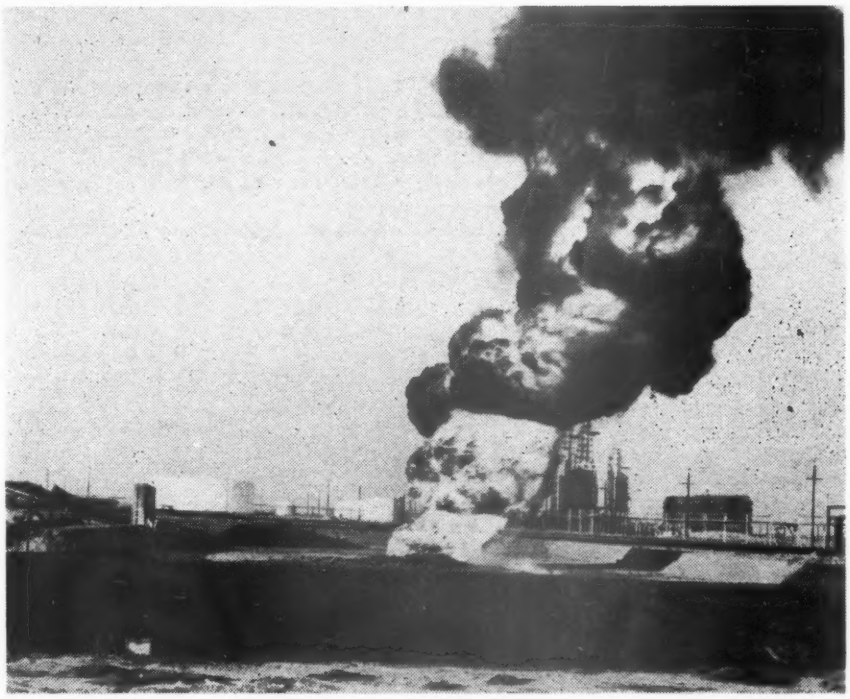
By **A. K. BRUMBAUGH, JR.**

General Petroleum Corporation

A great amount of publicity has been given to the so-called "smog" condition that has prevailed off and on in the City of Los Angeles for the last few years. As the intensity of the problem increased, General Petroleum undertook a study of its own smoke elimination problems at its Torrance Refinery, and as a result of these studies instituted a series of experimental tests. While these tests were being developed, General Petroleum, in addition to several other companies, was included in a complaint for injunction filed by the District Attorney of Los Angeles County.

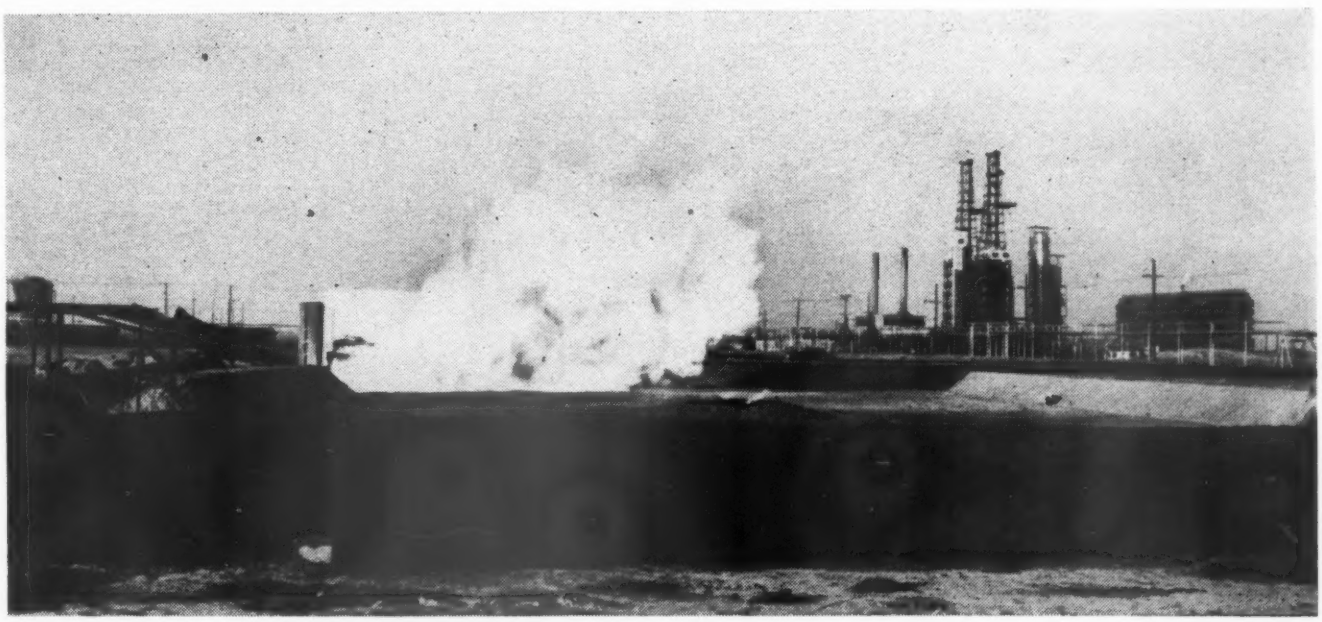
On the basis of its experiments, General Petroleum completed an installation that, after being put into operation, was inspected by authorities and was found effective. As a result of this inspection the complaint against General Petroleum was dismissed.

The accompanying report on this activity is being distributed for whatever constructive use it may be employed by those in the oil industry or others who have similar problems.



A convincing before and after contrast at General Petroleum Corporation refinery at Torrance, California. Above is a view showing the old method of burning emergency released light oil and gases, which created clouds of black smoke because of lack of aeration. The same scene below is after the new burner installation handling emergency released light oil and gas. Note the absence of smoke.

MANY refineries that happen to be situated in metropolitan areas face a severe problem in the disposal of waste light hydrocarbon materials, especially those gases and liquids that are discharged from safety relief valves and that consequently are produced in widely varying amounts not subject to direct control. This is particularly true of operations involving large gas-recovery, light-end fractionation, and alkylation units; for such equipment requires the holding in process vessels of considerable volumes of hydrocarbons. The special problems associated with materials in the propane-hexane range result from a combination of volatility at normal temperatures and vapor density appreciably greater than that of air; the high volatility means that



discharged material may not be readily condensed, for example by water washing, and the high vapor density slows down dispersion by natural forces and encourages the formation of pockets of gas.

Most operators of this type of equipment have concluded that the only safe method of handling such vented material is burning. Early in 1946 General Petroleum Corporation instituted a program aimed at the development of equipment that would burn vent gases without objectionable smoke. The following discussion outlines the basis of this development and describes the installation recently completed.

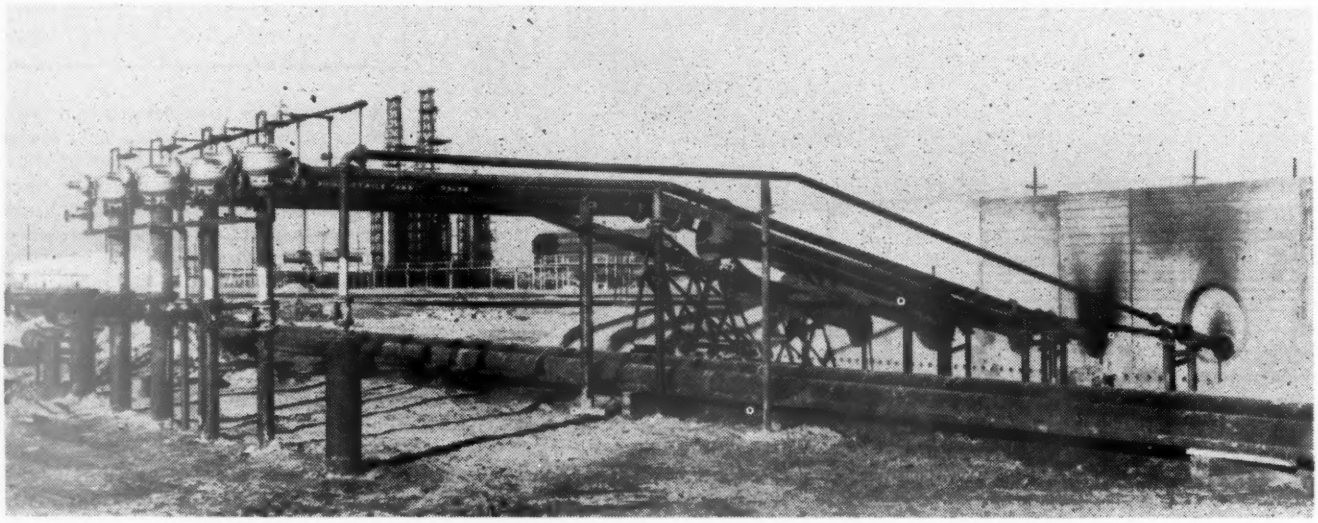
As a first step a rather careful search of the literature was made but no reports of any approach to the problem were found. Without previous background, various methods of supplying and mixing air with the gas prior to ignition were studied with the result that the design of a venturi type aspirating burner was attempted. Mechanical methods of aeration, for example by blowers, had to be ruled out because the volumes of gas to be handled were so great as to require equipment of prohibitive size. Information for the design of the experimental unit shown in Fig. 1 was obtained from three sources given in the bibliography and this unit was set up for field tests.

TABLE 1

Burner number	Cut in, psi	Cut out, psi	Gas orifice diam, in.	Venturi throat diam, in.	Ratio throat area to orifice area
1	2¼	¼	1.61	5.0	9.6
2	2¾	½	2.9	8.0	7.8
3	3¼	¾	4.03	11.5	8.1
4	3¾	1	7.0	18.0	6.6

It was found that isobutane vapors could be burned without smoke using a ratio of venturi throat area to gas orifice area of 4 to 1. When isobutane containing considerable amounts, possibly 20 per cent, of unvaporized material was fed to the burner it was necessary to substitute a smaller gas orifice thereby increasing this ratio to 16 to 1. With the 16 to 1 ratio the wet material burned without smoke, this despite the fact that liquid could be seen emerging from the burner mouth and entering the flame. Wet gas from the gas plant feed required a ratio of 8 to 1 for clean combustion. It was also determined that with the orifice ratio giving minimum satisfactory aeration the pressure upstream of the gas orifice could be reduced to ⅛ psig without flame popping back. Below this limit operation was unstable; eventually the flame would travel back through the venturi tube and burn at the gas orifice. It was discovered however that a pressure of about 1 psig would blow the flame through the tube and reestablish normal operation.

With the limitations of the venturi



Above is a view of regulator manifold and piping of burners. The concrete and brick wall at right is shown below in center from the sump side. Top of water seal is at lower left.

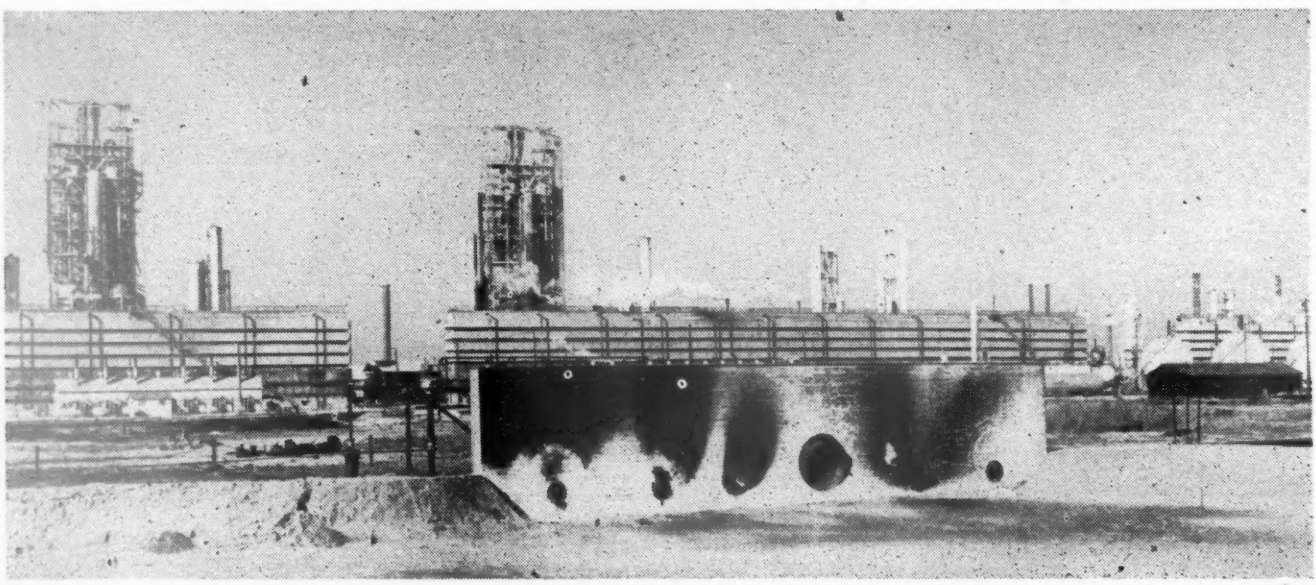
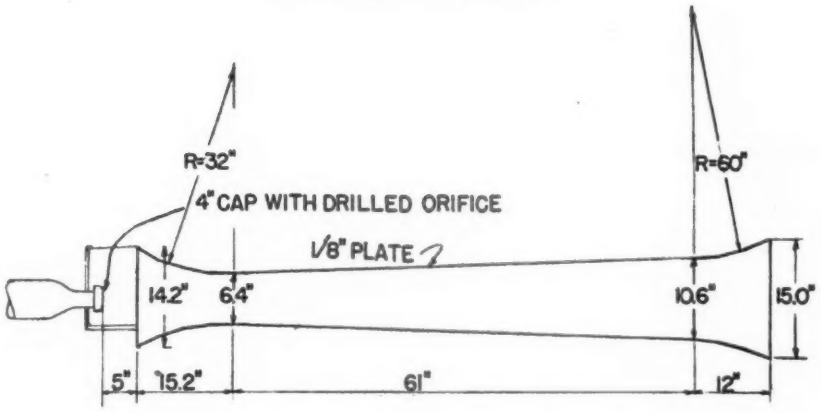


FIG. 1. Experimental burner.



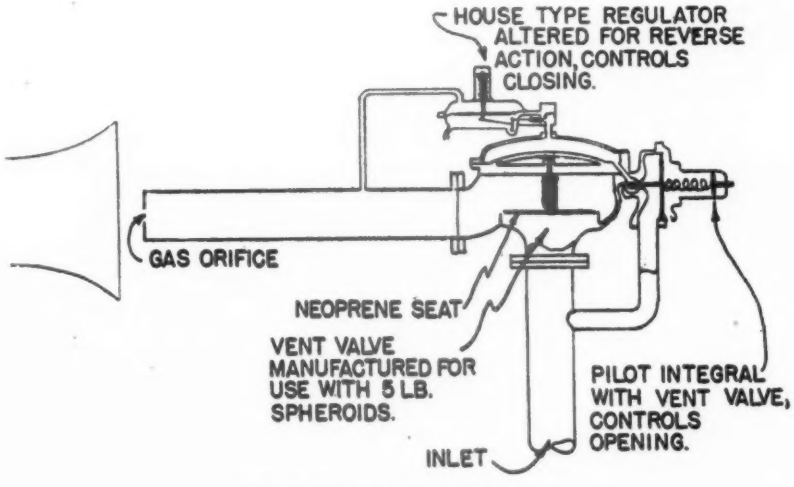
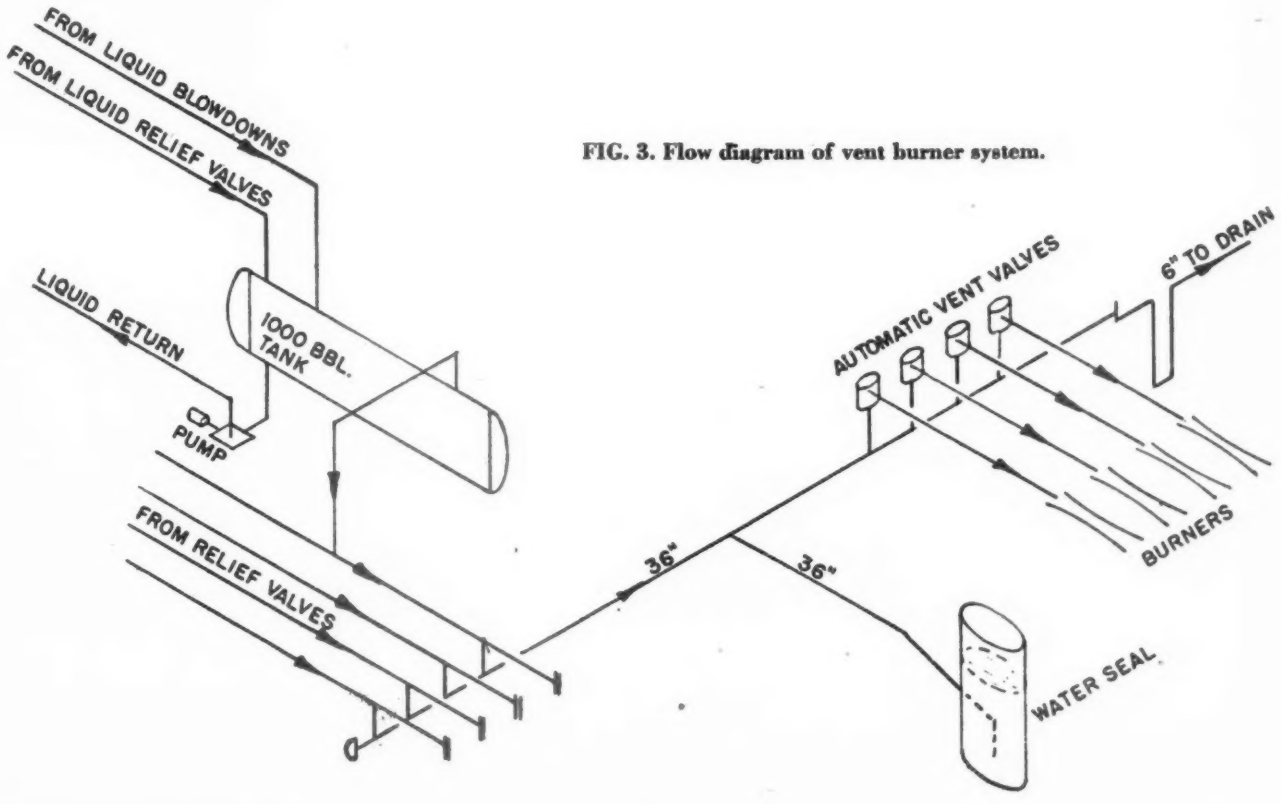

HOUSE TYPE REGULATOR ALTERED FOR REVERSE ACTION, CONTROLS CLOSING.
GAS ORIFICE
NEOPRENE SEAT
VENT VALVE MANUFACTURED FOR USE WITH 5 LB. SPHEROIDS.
PILOT INTEGRAL WITH VENT VALVE, CONTROLS OPENING.
INLET

FIG. 2. Vent burner control.

burner established, the application of such units to the refinery flare system was considered. As it was apparent that the permissible pressure at the gas orifice would control the size of the equipment, calculations were made to determine the effect of this back pressure on the relief valve system, with the result that 5 psig was chosen as the maximum figure. Because all the vessels tied into the burner system had design pressures of 100 psig or over, and the relief piping was adequately sized, it was found that for any reasonable assumption of emergency conditions the pressure rise in the protected vessel or vessels would be well within the margin of allowance set by the API-ASME Code. The effect of back pressure on the popping pressure of the relief valves could be ignored, as the greatest build-up at the downstream side of any valve was estimated at 15 psig, whereas the set pressure was at least 25 psig below the design pressure of the vessel in question. It was also decided to design the burner installation for a rate of 14,000,000 cu ft per day, this seeming sufficient to handle any discharge resulting from emergencies.

With an operating pressure range of ¼ psig to 4 psig, a given gas orifice would have a range of volume burned of 4 to 1. As the volume to be handled could be expected to vary from zero to the maximum it was decided to employ several burners of varying sizes with some sort of pressure responsive mechanism to cut them in successively. A conventional back-pressure control valve could not be used for this purpose for as soon as the burner was turned on the increased flow would drop the header pressure with the result that the valve would quickly shut off again, resulting in a

FIG. 3. Flow diagram of vent burner system.



GMV's....

Complete flexibility of control is a feature here at Southern Natural Gas Company's Wetumpka compressor station. These two GMV, 600 hp V-angles are set up for full automatic control or partial or full manual control of either or both units.

Control panel includes master pressure controller, applicable to either suction or discharge pressure, with provision for overall simultaneous manual control of speed and unloading. Four manual air switches provide for manual, individual unloading of crank end of each cylinder.

TYPE GMV ANGLE

Compressors

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash.

... the perfect answer to a problem at Wetumpka

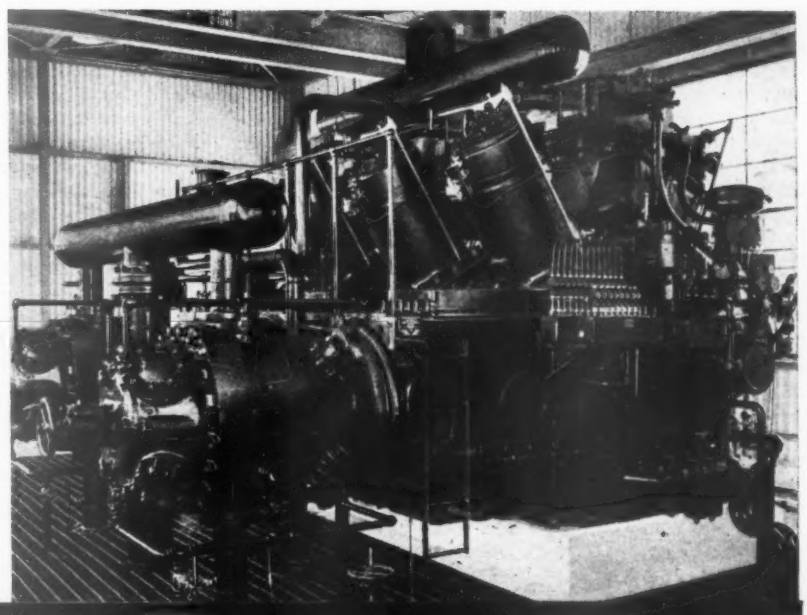
At Southern Natural Gas Company's Wetumpka, Alabama compressor station the gas supply drops during part of the day. It is desirable to maintain a constant discharge pressure when the supply is up; but not less than a specific suction pressure when the supply is low. Here again, GMV's are teamed with a patented Cooper-Bessemer method of automatic control for the ideal answer.

Automatic speed control is interposed between each step of 4-step, automatic-pneumatic compressor unloading.

THE ADVANTAGES ARE MANY

1. Positive, even control of either suction or discharge pressure at will, and without excessive speed range. Engine operation is remarkably stable.
2. At any capacity from 33⅓% to 100%, compressor capacity exactly matches load demand without continual loading and unloading of compressor steps.
3. All loading steps occur at maximum engine speed, where load increases are easily absorbed.
4. All unloading steps occur at minimum speed, where slight speed increase due to reduced load is not objectionable.
5. Compressor steps are not continually in operation, off and on, but remain in one position until load demand changes sufficiently to require additional steps.
6. Controlled pressure is exceptionally smooth and regular, free from the constant up-down variation common with previous step unloading systems.

Whether or not you need automatic control at its best, you'll always be ahead with Cooper-Bessemers. For Cooper-Bessemer V-angles — the modern GMV's and GMX's, 200 to 1000 hp — are first of all exceptionally reliable and efficient units for any kind of compressor service.



Each GMV drives two compressor cylinders, with provision for one step of unloading at one end of each cylinder, either automatically or manually controlled from control panel.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

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cyclic intermittent action. To meet this problem an adaptation of commercially available control valves was made as shown in Fig. 2. With this mechanism adjustment, one pilot valve sets the opening of the main valve at any desired header pressure while the other pilot valve permits adjustment of the closing point to that pressure on the burner orifice that is the minimum for satisfactory operation.

A schedule of opening and closing pressures was set up for the series of burners, arranged so that the largest unit would be the last to cut in and the first to cut out. The size of the smallest burner orifice was next determined, being estimated from the surge capacity of the entire piping system and the normal amount of vapor leakage so that this burner would operate at fairly infrequent intervals to discharge accumulated material. The size of the next larger orifice was calculated from that of the smallest and the operating pressure schedule, being limited so that both burners at the cut-out pressure of the second would burn only as much gas as the first burner alone at the cut-in pressure of the second. It will be seen that this method of graduation provides a stable operating condition for any gas flow in the range covered, thereby avoiding intermittent operation. Other gas orifices were determined maintaining a similar relationship between the capacity of each additional burner and the total of those that would have previously cut in. Venturi tube dimensions were established by direct proportion to the experimental unit, which had given good results, selecting a venturi area to orifice area of about 8 to 1 as the most generally desirable. Sizes and pressures finally used after slight readjustments to conform to readily available material and after field tests together with other pertinent data are included in Table 1.

To convey the vapors to the battery of burners all vent lines were combined in a 36 in. underground header, each burner having an individual riser to its control valve. Provision was made for continuous drainage of condensate, all vents being pitched from the relief valve to the header from whence a sealed gravity drain conducted liquid to the refinery recovery system. Because lack of capacity or failure of the automatic valves to operate might impair the functioning of the entire relief system, a branch of the main header was led to a water seal where its open end was submerged beneath 10 ft 4 in. of water, resulting in assured release of vapors at header pressures over 4½ psig.

In order to avoid liquid hydrocarbons reaching the burners, as well as to save valuable material for re-use, discharge lines from relief valves of all vessels operating full of liquid, and hand controlled drains from reflux drums and the like, were segregated and led to a 10 ft diam by 78 ft long accumulator that in turn was connected to the burner header. Liquid trapped in this vessel can be pumped back to the plant for recovery.

Experience with previous simple flare installations indicated that arrangement of the burner setting to provide satisfactory service life despite the tremendous evolution of heat during an emergency would require serious consideration. Experiments with the first unit showed that the aspirated air kept the venturi tube itself relatively cool so it was thought that if provision were made to protect the burners from radiated heat and flame from adjacent units, fabricated steel venturis could be used. Thicknesses varied from ¼ in. for the smallest sizes to ½ in. for the largest. An air-cooled wall 10 ft high and 50 ft long was constructed and the burners were installed flush with the surface through suitable ports. The wall consists of a 13-in. face of firebrick, a 2-in. air space, and an 8-in. thick reinforced concrete backing. Pipe nipples through the concrete along the bottom provide for convection circulation of air through the clearance space. The separate elements of this installation are coordinated in the flow chart Fig. 3. Various photographs of the equipment are included in the interest of clarity.

Since completion of the installation repeated operating tests have been made with uniformly good results.

Bibliography.

"The Aeration of Gas Burners," O. L. Kowalke and N. H. Ceaglske, *American Gas Association Proceedings* 1929, pp. 662-686.

U. S. Bureau of Standards, Circular 394.

U. S. Bureau of Standards, Technical Paper 193.

★ ★ ★

Why the middleman is helpful

By W. F. SCHAPHORST

MIDDLEMEN have been much maligned for many years. "Eliminate the middleman" has been the battle cry as far back as this writer can remember; however, middlemen possess certain important advantages, and here is a diagram that shows visually how to eliminate considerable commotion by utilizing middlemen and also the potential snarls that may develop without middlemen.

Fig. 1 shows what happens when 10 dealers deal directly with 10 manufacturers. The 100 connecting lines represent 100 transactions. If there were 20 dealers and 20 manufacturers there would be 400 transactions. Fig. 2 shows how the middleman simplifies the situation. Instead of 100 transactions for the dealers and for the manufacturers there are now only ten. In other words, the middleman reduces the number of transactions by 90 per cent. The greater the number of dealers and manufacturers involved, the greater the value of the middleman to both in effecting transacting of business.

The telephone is an excellent illustration. If there were 20,000,000 telephones in this country, and if all "centrals" should be eliminated, each telephone would be obliged to have a direct line to every other telephone. How many lines would there then be? In view of the above the answer is 20,000,000 × 20,000,000 or 400,000,000 lines. The cost of such a system, of course, would be unbearable.

FIG. 1

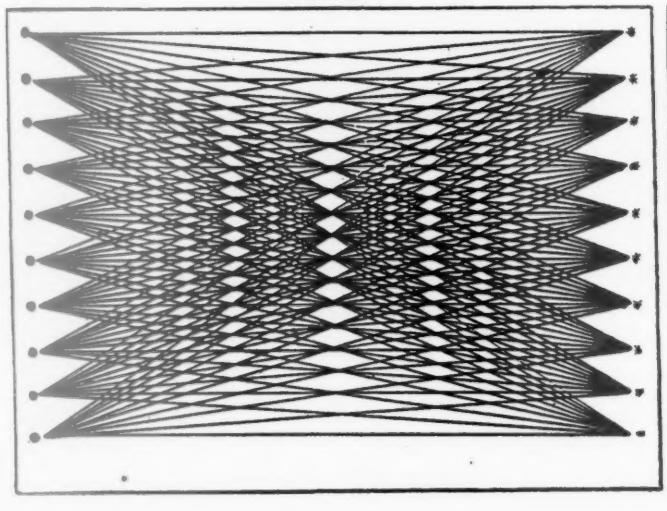
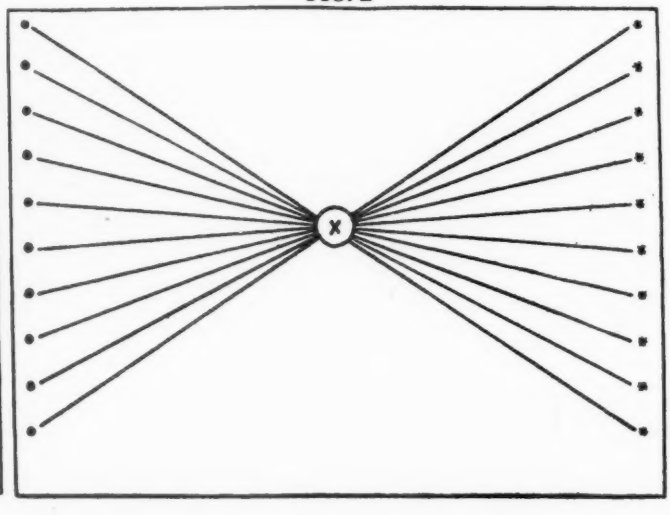


FIG. 2



Heating and cleaning Santa Maria heavy crude

By **ROBERT L. LAUENSTEIN,*** Union Oil Company of California

EXCLUSIVE

THE gravity of the oil produced in the southeast portion of the Santa Maria Valley field will range from 7 to 14 deg API and have a 100 F viscosity range from 20,000 to 200,000 SUS. With an average lead-line temperature of 60 F, there is need for a new unit of viscosity measurement in terms of days instead of seconds. The heaviest oil will run as high as 2,000,000 SUS or 23 days. The oil will carry a water cut of 12 per cent, a sand cut of 0.5 to 8 per cent, and a relative low gas-oil ratio of 200 cu ft per bbl. These properties form a difficult combination to handle through the gas-oil separator, the desander, and the stock tanks. It was first found necessary to heat the oil in the stock tanks in order to flow the oil to the transfer pumps. Then, the desanding process required heating the oil to effect a dropping of the sand. The gas-oil separator would blow slugs of cold heavy oil and gas through the oil flow line into the desander, agitating the water bath and exciting the oil to "boil over." Heating the oil ahead of the gas trap lowered the viscosity so that the oil separation could be made in a normal manner, corrected the "boil over," and reduced the foam in the stock tank.

The most practical means of heating the oil ahead of the gas trap is to insert a vertical flow-line heater to the gas-oil separator. This eliminates the possibility of sand and mud dropping to the bottom and fouling the tubes.

A typical flow-line heater is made in the following manner. The shell consists of a 16-in. pipe 10 ft long with a flue-sheet welded in each end. One inch seamless pipe makes the most satisfactory element. Forty-two of these 1-in. tubes will provide 145 sq ft of heating surface. A cone or swedge is then welded on the ends of the heater to bring the heater down to line size. In operating the heater the oil should pass through the 1-in. tubes, steam should be admitted at the top of the shell and pass out at the bottom. This heater, operating on 15 lb steam, is capable of heating 800 bbl per day of oil carrying 12 per cent water from 68 F to 138 F. The apparatus operates on a heat transfer of 20 Btu per sq ft per °F temperature difference per hr.

Sand lines from the bottom of separators have no value for flushing such heavy oil. In order to free the separator of sand packing, the oil outlet is taken off the bottom of the separator.

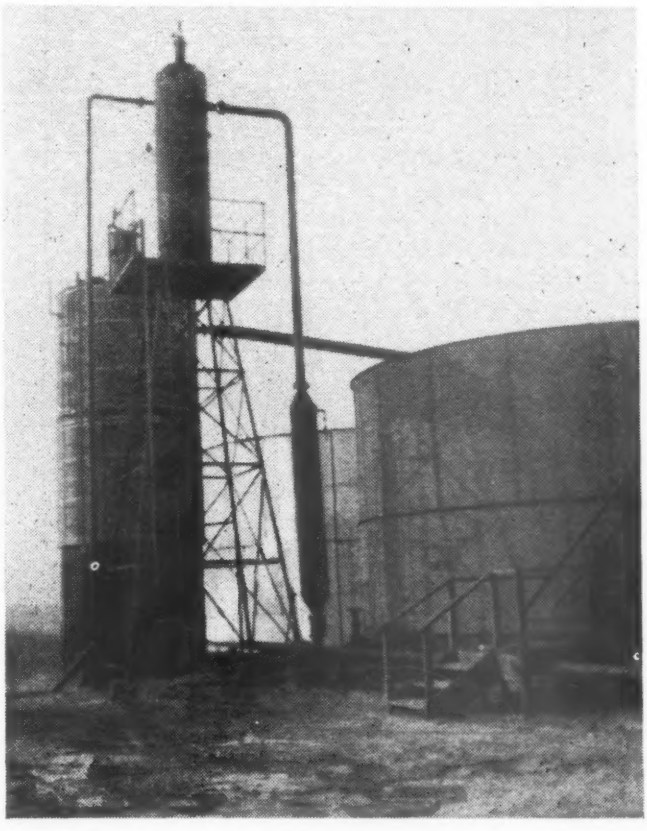
There are three other distinct advantages of heating oil ahead of the gas-oil separator:

(1) The cold heavy Santa Maria Valley crude oil does not readily liberate the entrained gas and deposits a foam in that tank, which can utilize between 10 ft and 12 ft of the 16 ft stock tanks. When the crude oil is heated to 130 F, practically all the natural gas breaks free and relieves a foaming condition in the stock tank. This is the same effect as adding three to four rings to each stock tank, costing about $1000 per tank. Heating also eliminates the agitation, which aids the settling of sand and water in the stock or wash tanks.

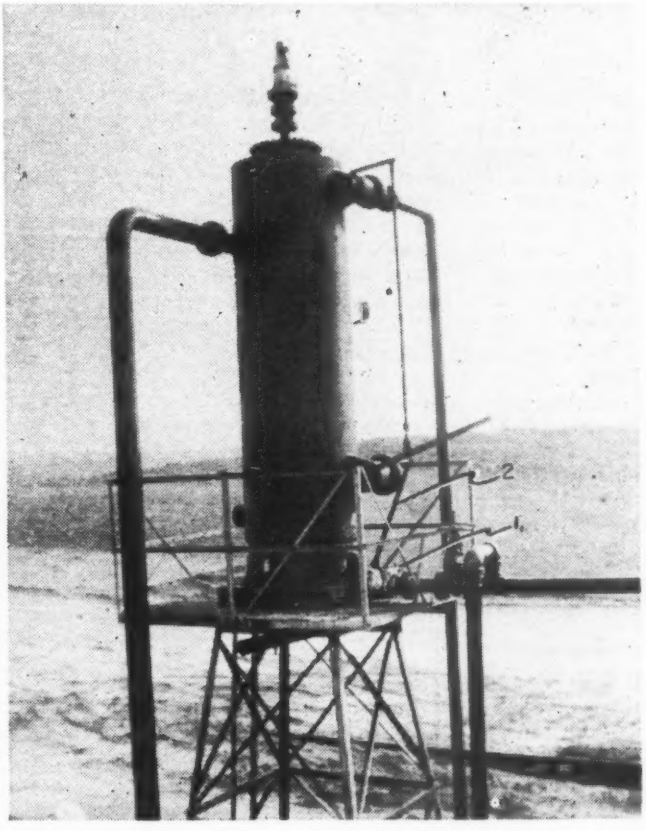
(2) The release of the vapors in the gas-oil separator salvages valuable gaso-

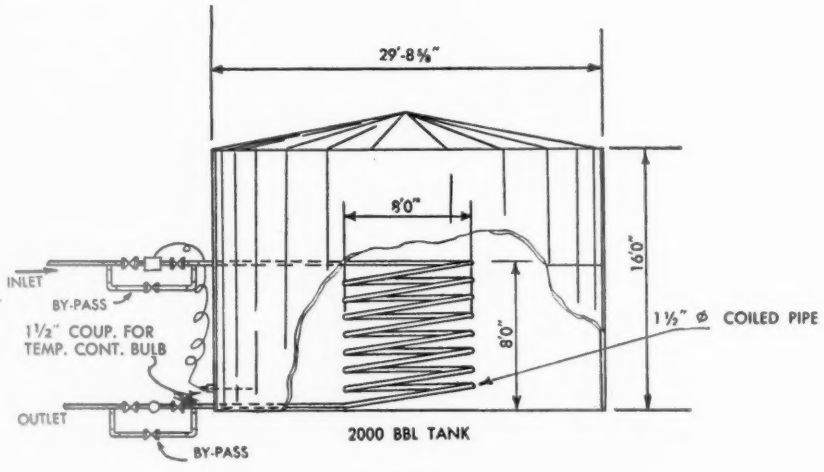
*No. 1 Field Operator, Santa Maria Valley.

The line heater is long upright cylinder in center, attached to the separator on tower at left.



Close-up of gas-oil separator showing (1) oil valve at bottom and (2) extension connecting link to oil valve.





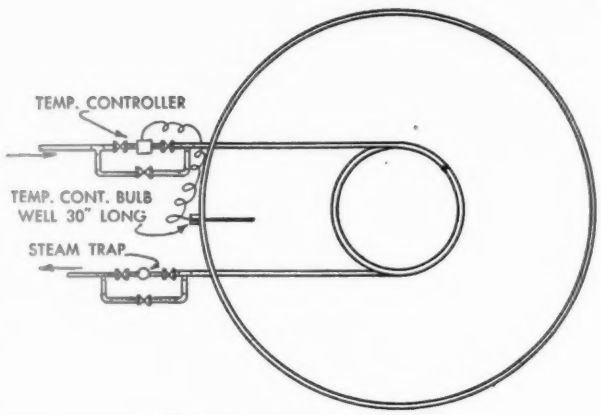


FIG. 1.
DIAGRAMMATIC SKETCH OF LOW PRESSURE STEAM OR HOT WATER.

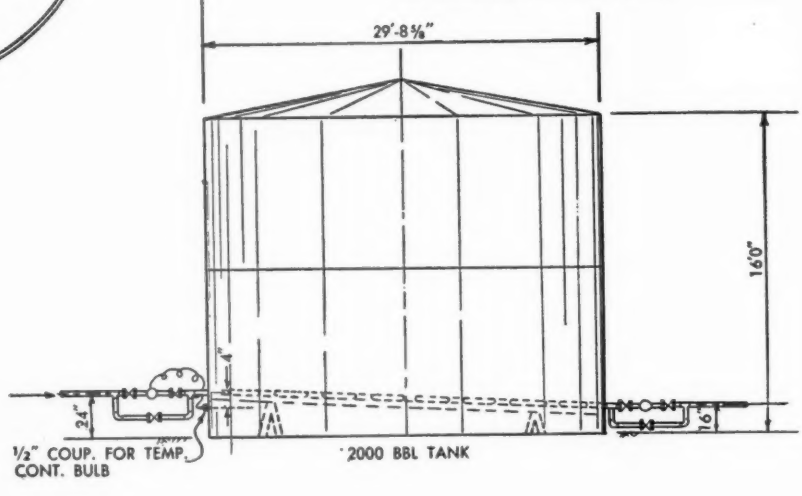
line and LPG hydrocarbons through the gas-gathering system that otherwise would be wasted to the air by heating the stock tank. For example, in one case the apparent yield in gasoline was increased from 0.49 to 1.21 gal per M cu ft, an increase of 147 per cent. The apparent LPG yield was 0.38 and increased to 0.43 gal per M cu ft, an increase of 13 per cent.

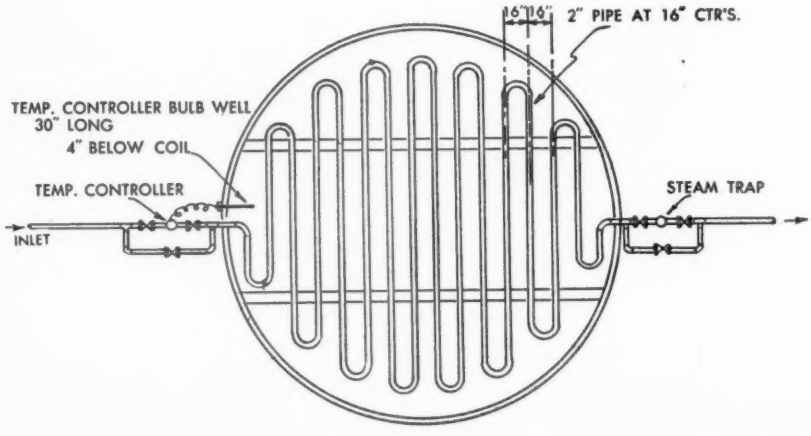
(3) The foaming condition also complicates the flow through the wash tank or desander unless it has been preheated. One example of this: A four-ring 3000-bbl API tank was used as a desander. It had a 12-in. overflow line to the stock tank at the top of the third ring. This gave 8 ft head over the stock tank and 8 ft above the overflow line, but was inadequate to handle a flow of 2000 bbl per day of foamy oil. All the foam was eliminated when a line heater was installed ahead of the gas-oil separator.

● **Heating to clean the oil.** The oil usually goes directly from the gas-oil separator to a wash tank or desander. The oil in these tanks is heated to approximately 170 to 180 F to drop out the sand and mud. If the temperature goes above 185 F the oil rolls in the tank, picking up water, and reduces the desanding efficiency. The cut cannot be dropped below 10 per cent in such equipment.

The maintenance of a constant temperature in a desander is most important. The most satisfactory position to install the temperature controller bulb has been 36 in. inside from the shell of the desander and 18 in. below the oil outlet. The water level should be maintained to within 4 ft of the oil outlet. This gives a maximum amount of wash and also leaves sufficient room for the water to settle before oil goes to the stock tank.

● **Heating oil to ship.** The lowest possible temperature should be used when heating oil to ship. The temperature will depend on the gravity and viscosity characteristics of the oil and the distance to be shipped. In general, a viscosity of 5000 SUS is adequate to flood the suction of the shipping pump. Either a vertical or horizontal coil may be used to heat a tank for shipping. A vertical coil is least expensive to install and maintain and requires less pipe to heat the same quantity of oil. It heats more rapidly, but has a tendency to roll the oil and it picks up sand, mud, and water from the bottom of the tank. The horizontal coil causes less disturbance of the oil. It heats the outside of the tank at the same rate as the center.





the OIL you leave behind..

Each barrel of oil in a producing reservoir has a given number of units of gas associated with it. If you produce a well in such a manner that the ratio of produced gas to produced oil is greater than this natural solution, you will be bringing to the surface some of the gas that originally belonged to a barrel of oil left in the reservoir. If this producing condition exists, you are actually stealing gas from the reservoir and depriving the remaining oil of its energy necessary to bring it to the surface.

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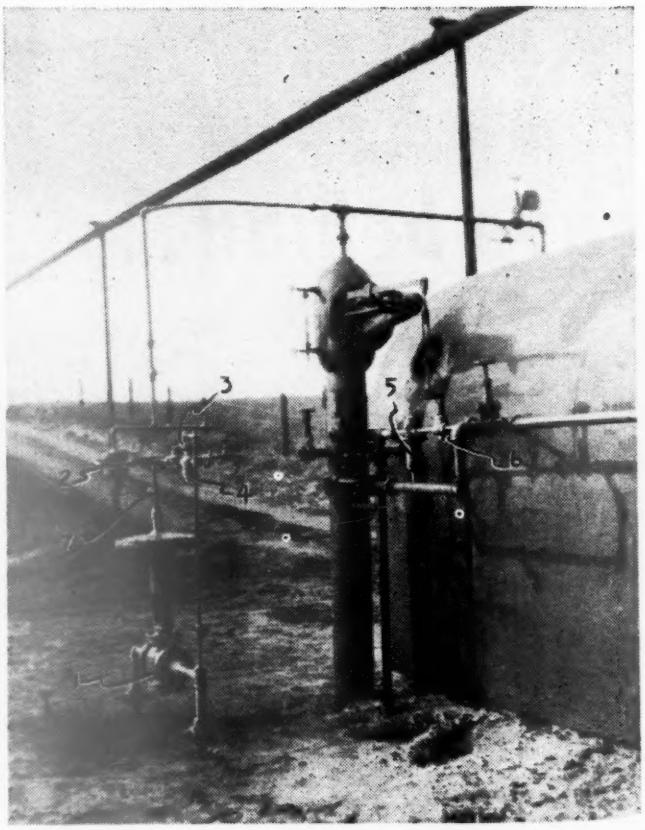

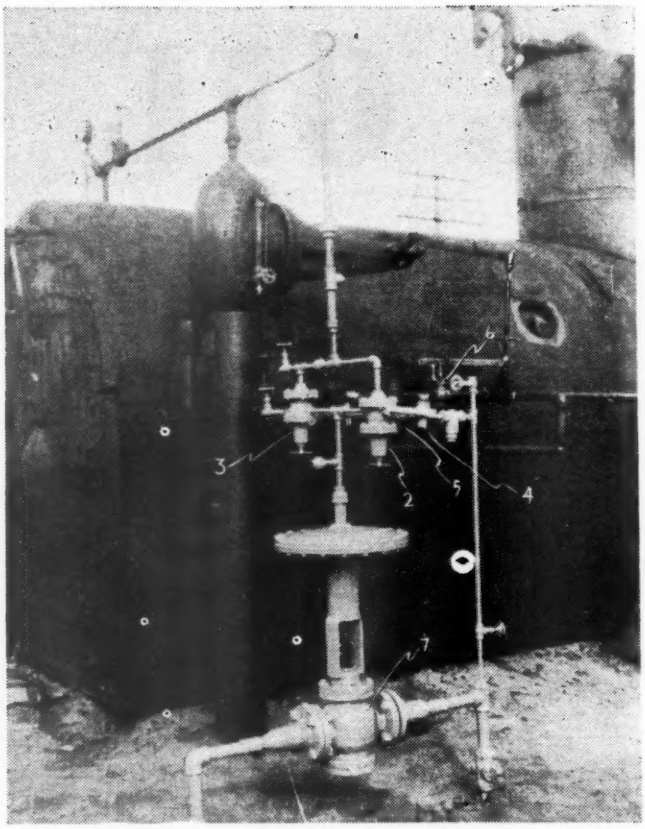

Two views of low pressure automatic boiler used to heat oil for treating or shipping. Indicated are: (1) Reducing pressure regulator, (2) back pressure duplex pilot regulator, (3) reducing pressure duplex pilot regulator, (4) reducing pressure regulator, (5) reducing pressure regulator on water, (6) soft seat lever-operated water make-up valve, and (7) wire drill orifice gas bleed. All boilers are equipped with a small pilot fire, gas supply ahead of boiler fuel regulator.

A vertical coil must be constructed in a cylindrical coil fashion as shown in Fig 1.

A horizontal coil should have at least a 6 in. drop from the inlet to the outlet to permit condensate to gravitate to the outlet and prevent a back pressure on the boilers. The coil should be placed 2 to 3 in. below the oil outlet so it will always be completely submerged. If the coil is placed on the bottom of the tank it will be covered with a deposit of mud and sand and thereby impair its heating effectiveness. The following cuts indicate the desirability of using the horizontal coil where the oil is dirty. Six tanks heated with horizontal coils cut 12.6 per cent, whereas six tanks of the same oil heated with the vertical coil cut 23.4 per cent.

It is economically sound to equip tanks with automatic temperature controls. There is considerable variation in temperature from the top to bottom of the tanks as the following indicates: The bottom temperature 12 in. in from the shell was 154 F; 36 in. in, 172 F, and 72 in. in. 178 F. Top temperature 12 in. in from the shell was 136 F; 36 in. in, 156 F, and 72 in. in, 165 F. The best position for the temperature control bulb, as indicated by the preceding tank temperatures, is at least 36 in. in from the shell of the tank. Where a horizontal coil is used, the bulb should be at least 12 in. from the coil and 4 in. below the coil level. In this position the coil and the controller bulb will always be submerged and in service. A check of an indentical battery of tanks of six tanks heated by hand control cut 11.2 per cent water with a trace of mud, whereas six tanks of the same oil but on controls cut 7 per cent water.

Steam traps should be installed on coil outlet in order to cause the greatest amount of heat transfer to the oil before the condensate returns to the boiler. The following example further illustrates the saving in gas fuel used in heating a tank setting, including a desander, with all tanks on controllers: 64 M cu ft of gas was used to supply steam heat where the same tank heating on hand control consumed 110 M cu ft of gas per day, a saving of 41.8 per cent in gas burned. By insulating the desander on which a temperature at 185 F was maintained another 6 M cu ft of gas was saved per day.

Fifteen pounds of steam pressure is sufficient to heat oil for treating or shipping. As no fireman is required when boilers are operated at this low pressure, the boiler can be made completely automatic. An electric or steam operated pump should be installed to return the water from the return water tank to the boiler. A kidney type controller is installed on the side of the boiler to operate the make-up water valve. As very little make-up water is needed, a soft seat lever-operated valve gives the best results.

A pilot-controlled regulator is used on fuel gas. Installed in a reducing pressure position, this type regulation will maintain steam pressure within 1 lb of set pressure. A duplex pilot installed in reduced pressure position is used in conjunction with back-pressure pilot set 3 lb below back-pressure pilot setting. This reducing pressure pilot will shut the gas off in case pressure decreases for any reason, such as burning out a soft plug. This regulator is installed in such a position that it has to be reset manually.

All boilers are equipped with a small pilot fire, the gas supply to be taken off ahead of the boiler fuel regulator. Installed in this manner, if the fuel regulator closes momentarily and then opens, it will not affect the pilot light, eliminating the possibility of filling of the fire box with unburned gas. ★★★

☆ ☆ ☆ ☆

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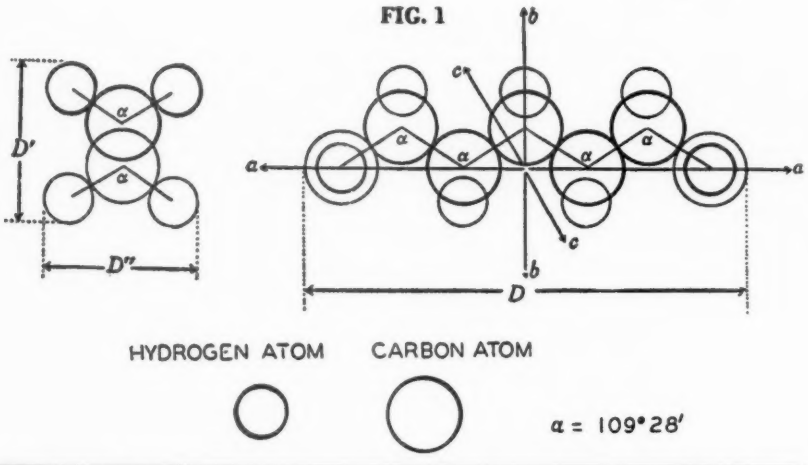
Chemical structure affects knocking

By **PETER J. GAYLOR**

FIG. 1



IN A PREVIOUS article[1], information was submitted indicating that knock-free power obtainable from a fuel is determined by the maximum pressure developed, the rate of pressure rise, and the spontaneous ignition temperature—all data being obtained at engine conditions. The last factor particularly, and to some extent the second, are influenced by chemical structure of the fuel, and hence the present article is being presented to enlarge more upon the effect of chemical structure on knocking characteristics.

EXCLUSIVE

It is a well known fact that compactness of a molecule is a fairly good measure of knocking properties—the more compact the molecule, the lower is the knocking tendency, and, conversely, the higher is the octane number. No good single numerical value has been advanced in this country, however, for evaluating the property of compactness in the case of fuels. A search of the literature has revealed some work done by Kobayasi[2] that seems to provide a measure for the purpose.

If we take the n-pentane molecule, as illustrated in Fig. 1, we find that it can be designated as having three dimensions, its length (D), its height (D'), and its width (D''). Kobayasi has taken the various instabilities of the molecule in the three directions to be α, β, and γ, and has evaluated them numerically as follows:

$$\alpha : \beta : \gamma = D/D : D'/D : D''/D = 1 : D'/D : D''/D$$

The products $\alpha\beta\gamma$, which he calls the "unstability" factor, or which we can call the *stability index*, can be designated as:

$$\alpha\beta\gamma = D'/D \cdot D''/D = D'D''/D^2$$

In reality, this dynamic stability factor indicates the closeness to which the molecule approaches a sphere while rotating (the factor for which would be 1, for the dimensions are the same in all directions), and hence determines the stability of the molecule toward thermal disintegration or attack by oxygen molecules or atoms. Various physical properties, such as melting point, boiling point, etc., have been correlated with this factor[3].

Kobayasi has indicated that this sta-

TABLE 1. Calculated octane numbers of the paraffin hydrocarbons.

Paraffin hydrocarbons C_nH_{2n+2}	Blending octane no. Calc.	Obs.
n-Pentane	55	60
n-Hexane	32	29
n-Heptane	2	0
n-Octane	−18	−19
n-Nonane	−34	−34
n-Decane	−47	—
n Undecane	−56	—
n-Dodecane	−64	—
2-Methyl butane	90	92
2-Methyl pentane	72	69
3-Methyl pentane	84	84
2 Methyl hexane	54	55
3-Methyl hexane	63	65
2-Methyl heptane	29	—
3-Methyl heptane	39	—
4-Methyl heptane	59	—
2-Methyl octane	0	—
3-Methyl octane	8	—
4 Methyl octane	26	—
2-Methyl nonane	−21	—
3-Methyl nonane	−16	—
4-Methyl nonane	− 7	—
5-Methyl nonane	24	—
2 Methyl decane	−37	—
3-Methyl decane	−34	—
4-Methyl decane	−29	—
5-Methyl decane	−15	—
2-Methyl undecane	−48	—
3-Methyl undecane	−46	—
4-Methyl undecane	−43	—
5-Methyl undecane	−37	—
6-Methyl undecane	−13	—
2,2 Dimethyl propane	144	116
2,2-Dimethyl butane	100	101
2,3-Dimethyl butane	108	124
2,2-Dimethyl pentane	79	80
2,3-Dimethyl pentane	96	94
2,4-Dimethyl pentane	84	80
3,3-Dimethyl pentane	96	98
2,2-Dimethyl hexane	62	—
3,3-Dimethyl hexane	73	—
2,3-Dimethyl hexane	73	—
2,4 Dimethyl hexane	73	—
2,5 Dimethyl hexane	67	—
3,4-Dimethyl hexane	79	—
2,3-Dimethyl heptane	54	—
2,4-Dimethyl heptane	68	—
2,5-Dimethyl heptane	54	—
2,6-Dimethyl heptane	47	36
3,4-Dimethyl heptane	72	—
3,5 Dimethyl heptane	59	—
2,2-Dimethyl heptane	39	—
3,3-Dimethyl heptane	52	—
4,4-Dimethyl heptane	70	—
2,3-Dimethyl octane	28	—
2,4-Dimethyl octane	42	—
2,5-Dimethyl octane	42	—
2,6-Dimethyl octane	28	—
2,7-Dimethyl octane	19	25
3,4 Dimethyl octane	46	—
3,5 Dimethyl octane	46	—
3,6-Dimethyl octane	35	—
4,5-Dimethyl octane	56	—
2,2 Dimethyl octane	11	—
3,3-Dimethyl octane	24	—
4,4-Dimethyl octane	46	—
2,3-Dimethyl nonane	− 2	—
2,4-Dimethyl nonane	8	—
2,5-Dimethyl nonane	38	—
2,6-Dimethyl nonane	8	—
2,7-Dimethyl nonane	− 2	—
2,8-Dimethyl nonane	− 7	—
3,4 Dimethyl nonane	14	—
3,5-Dimethyl nonane	40	—
3,6-Dimethyl nonane	14	—
3,7-Dimethyl nonane	4	—
4,5 Dimethyl nonane	48	—
4,6-Dimethyl nonane	25	—
2,2-Dimethyl nonane	−18	—
3,3-Dimethyl nonane	− 6	—
4,4 Dimethyl nonane	10	—
5,5-Dimethyl nonane	49	—
2,3-Dimethyl decane	−23	—
2,4-Dimethyl decane	− 7	—
2,5-Dimethyl decane	5	—
2,6-Dimethyl decane	5	—
2,7-Dimethyl decane	− 7	—
2,8-Dimethyl decane	−23	—
2,9-Dimethyl decane	−27	—
3,4-Dimethyl decane	−14	—
3,5-Dimethyl decane	0	—
3,6-Dimethyl decane	0	—
3,7-Dimethyl decane	−14	—
3,8-Dimethyl decane	−20	—
4,5-Dimethyl decane	6	—
4,6-Dimethyl decane	6	—
4,7 Dimethyl decane	− 9	—
5,6-Dimethyl decane	22	—
2,2-Dimethyl decane	−31	—
3,3-Dimethyl decane	−26	—
4,4-Dimethyl decane	−17	—
5,5-Dimethyl decane	3	—
2,2,3-Trimethyl butane	119	116
2,2,4-Trimethyl pentane	90	100
2,2,3-Trimethyl pentane	102	105
2,3,3-Trimethyl pentane	108	—
2,2,3-Trimethyl hexane	79	—
2,2,4-Trimethyl hexane	79	—
2,2,5-Trimethyl hexane	73	—
2,3,3-Trimethyl hexane	81	—
3,3,4-Trimethyl hexane	86	—
2,4,4-Trimethyl hexane	81	—
2,3,4-Trimethyl hexane	87	—
2,3,5-Trimethyl hexane	82	—
2,2,3-Trimethyl heptane	60	—
2,2,4-Trimethyl heptane	72	—
2,2,5-Trimethyl heptane	60	—
2,2,6-Trimethyl heptane	55	—
2,3,4-Trimethyl heptane	79	—
2,3,5-Trimethyl heptane	68	—
2,3,6-Trimethyl heptane	64	—
2,4,5-Trimethyl heptane	79	—
2,4,6-Trimethyl heptane	76	—
2,3,3-Trimethyl heptane	63	—
2,4,4-Trimethyl heptane	79	—
2,5,5-Trimethyl heptane	63	—
3,3,4-Trimethyl heptane	78	—
3,3,5-Trimethyl heptane	67	—
3,4,4-Trimethyl heptane	82	—
3,4,5-Trimethyl heptane	82	—
3,5,5-Trimethyl heptane	67	—
2,2,3-Trimethyl octane	37	—
2,2,4-Trimethyl octane	48	—
2,2,5-Trimethyl octane	48	—
2,2,6-Trimethyl octane	37	—
2,2,7-Trimethyl octane	31	—
2,3,4-Trimethyl octane	57	—
2,3,5-Trimethyl octane	57	—
2,3,6-Trimethyl octane	47	—
2,3,7-Trimethyl octane	43	—
2,4,5-Trimethyl octane	64	—
2,4,6-Trimethyl octane	57	—
2,4,7-Trimethyl octane	53	—
2,5,6-Trimethyl octane	57	—
2,3,3-Trimethyl octane	41	—
2,4,4 Trimethyl octane	56	—
2,5,5-Trimethyl octane	56	—
2,6,6 Trimethyl octane	41	—
3,3,4-Trimethyl octane	55	—
3,3,5-Trimethyl octane	55	—
3,3,6-Trimethyl octane	45	—
3,4,5 Trimethyl octane	66	—
3,4,6-Trimethyl octane	60	—
3,4,4-Trimethyl octane	59	—
3,5,5 Trimethyl octane	59	—
4,4,5-Trimethyl octane	66	—
2,2,3-Trimethyl nonane	1	—
2,2,4-Trimethyl nonane	11	—
2,2,5-Trimethyl nonane	40	—
2,2,6-Trimethyl nonane	11	—
2,2,7 Trimethyl nonane	1	—
2,2,8-Trimethyl nonane	− 4	—
2,3,4 Trimethyl nonane	20	—
2,3,5-Trimethyl nonane	50	—
2,3,6-Trimethyl nonane	30	—
2,3,7-Trimethyl nonane	19	—

(Continued on Page 76)

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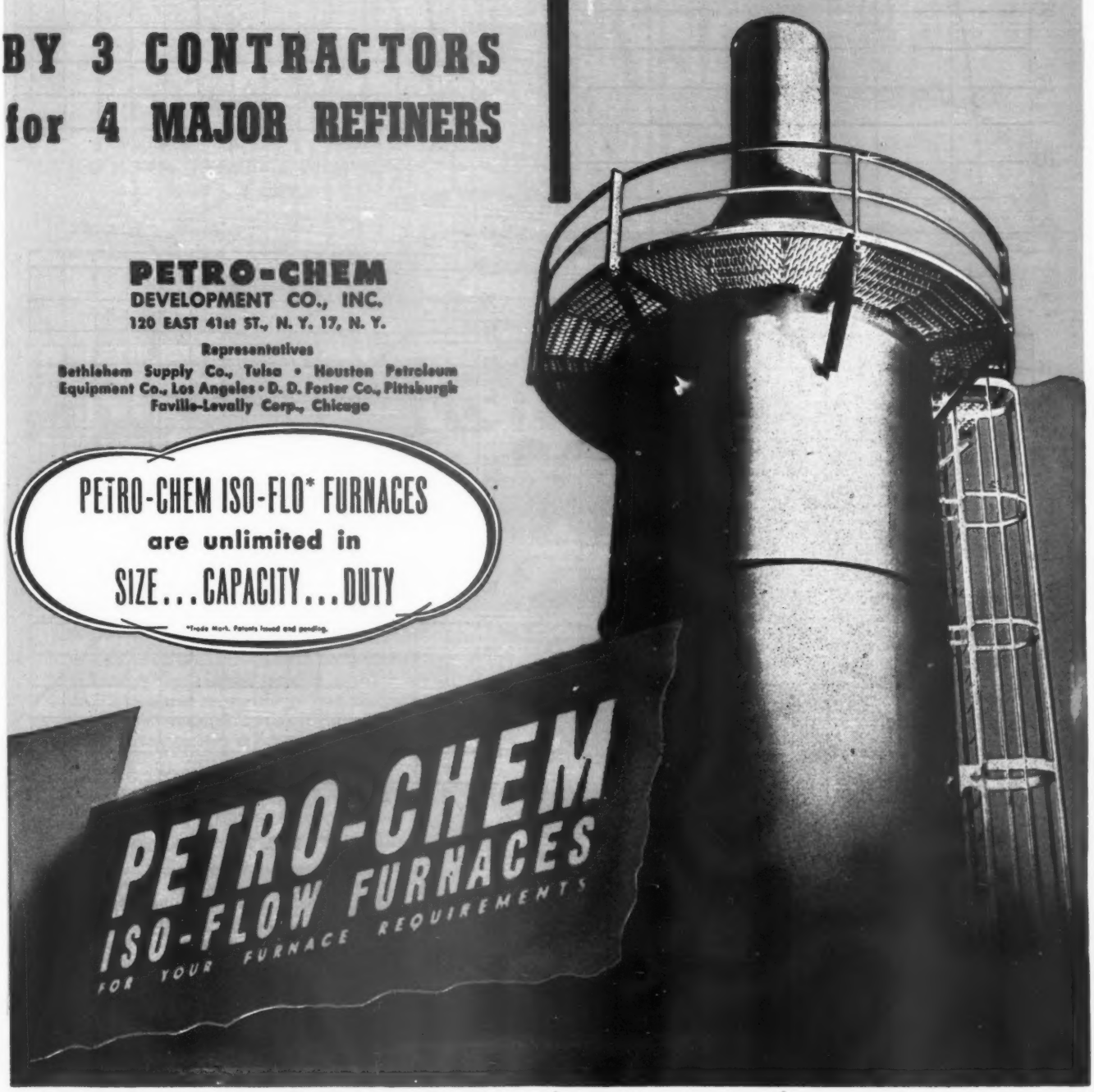

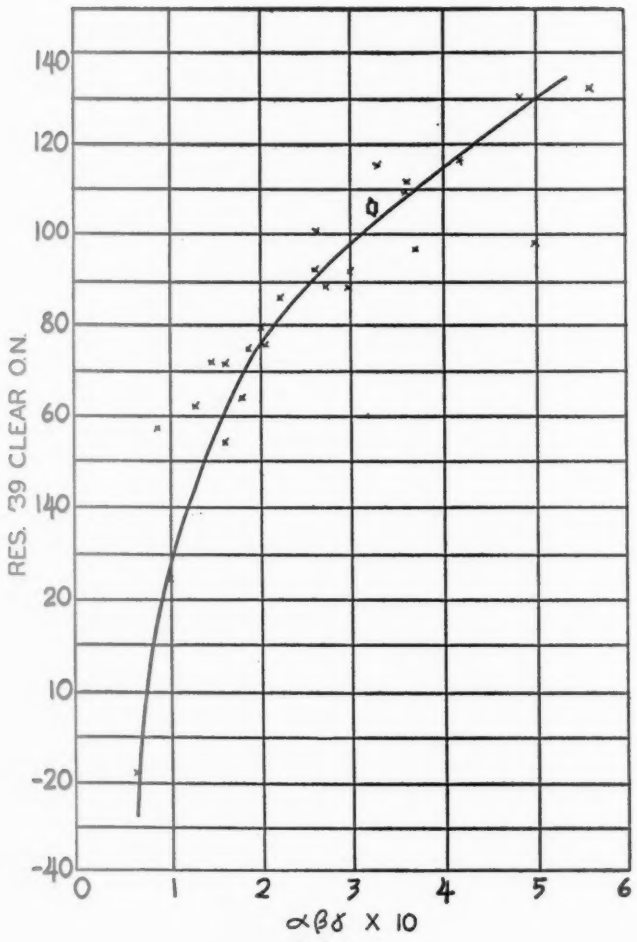

FIG. 2

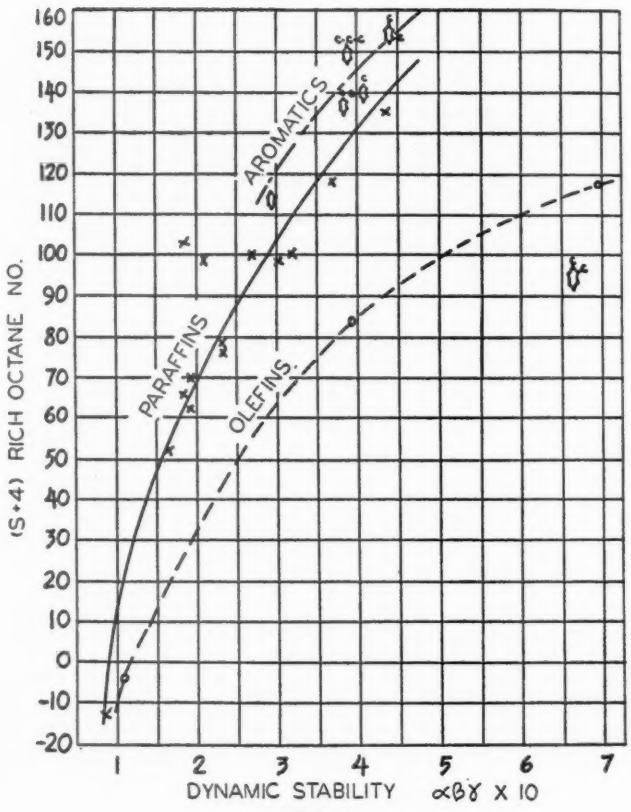

FIG. 3

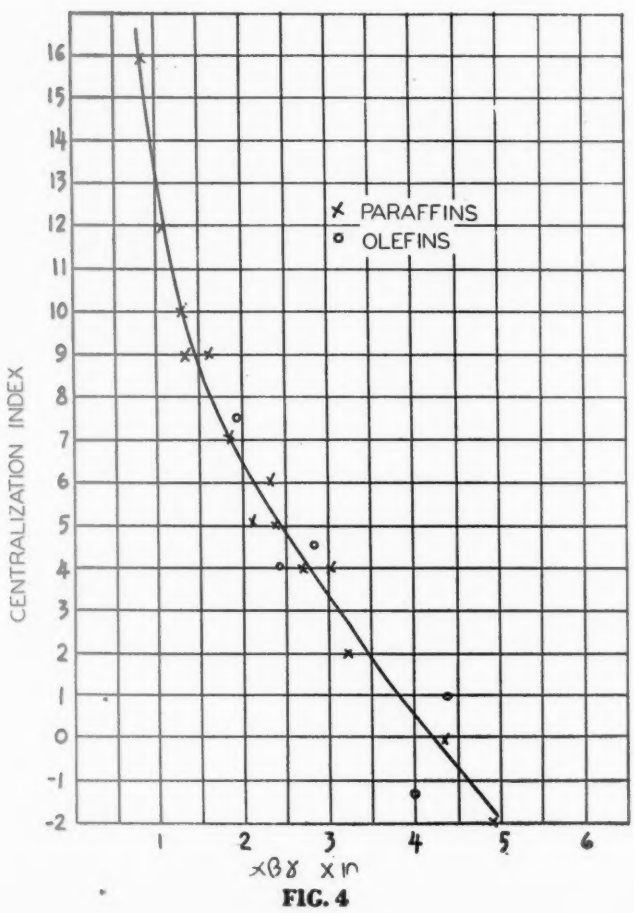

FIG. 4

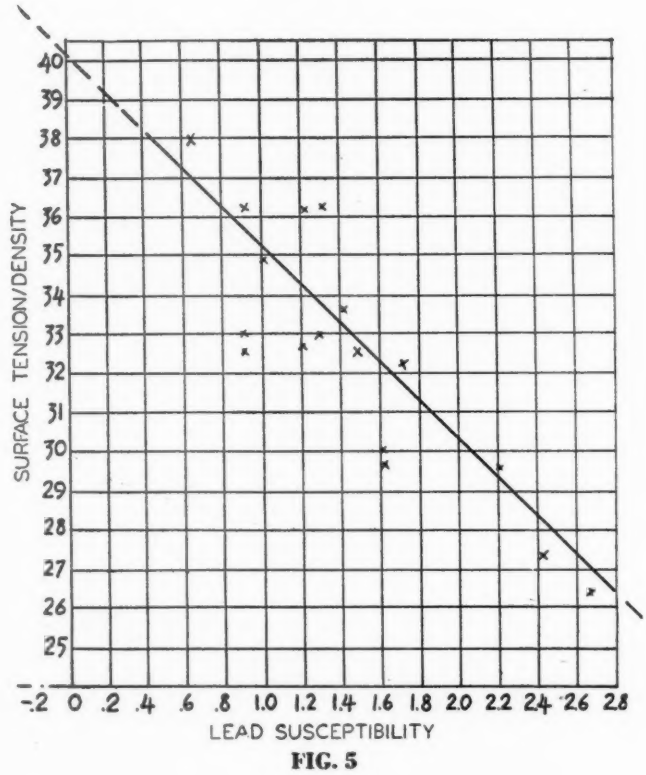

FIG. 5

bility index ($\alpha\beta\gamma$) is related to clear blending octane numbers of paraffin and olefin hydrocarbons, and Tables 1 and 2 show some of his predicted knock data, whereas Table 3 lists some dimensional data. The Research '39 clear octane numbers of various pure hydrocarbons listed in Doss, Third Edition, have been plotted in Fig. 2 against Kobayasi's calculated values for $\alpha\beta\gamma$, and although a few discrepancies are noted in the high octane range, there is support for his observations, which were based on much older data.

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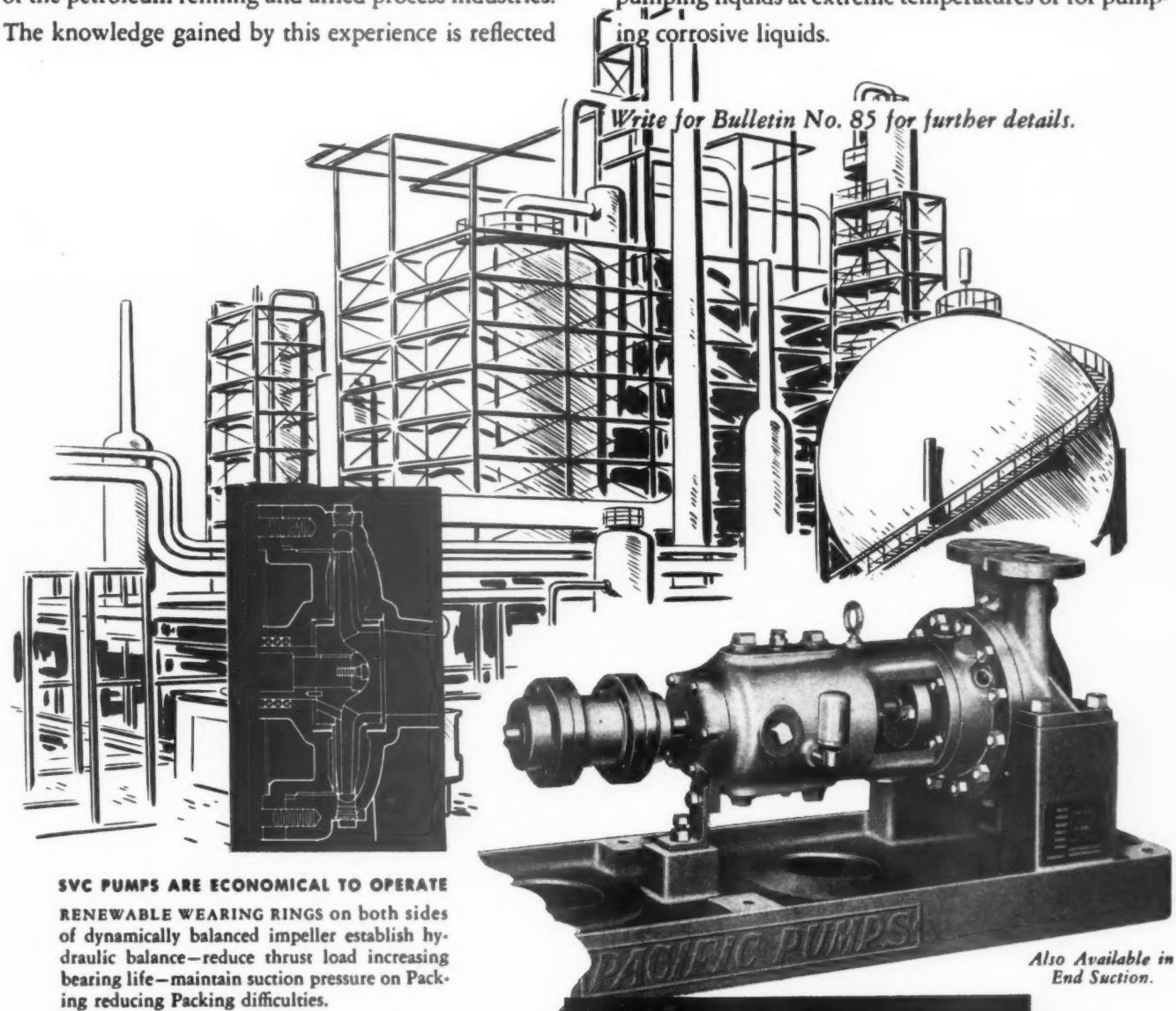

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SVC PUMPS ARE ECONOMICAL TO OPERATE

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PACIFIC
Precision Built
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TABLE 1, continued from page 72

Paraffin hydrocarbons CnH2n+2	Blending octane no. Calc.	Obs.
2,3,6-Trimethyl nonane	14	—
2,4,5-Trimethyl nonane	56	—
2,4,6-Trimethyl nonane	38	—
2,4,7-Trimethyl nonane	30	—
2,4,8-Trimethyl nonane	24	—
2,5,6-Trimethyl nonane	56	—
2,5,7-Trimethyl nonane	50	—
2,5,8-Trimethyl nonane	48	—
2,6,7-Trimethyl nonane	30	—
2,3,3-Trimethyl nonane	10	—
2,4,4-Trimethyl nonane	27	—
2,5,5-Trimethyl nonane	57	—
2,6,6-Trimethyl nonane	27	—
2,7,7-Trimethyl nonane	10	—
3,3,4-Trimethyl nonane	26	—
3,3,5-Trimethyl nonane	48	—
3,3,6-Trimethyl nonane	26	—
3,3,7-Trimethyl nonane	16	—
3,4,5-Trimethyl nonane	58	—
3,4,6-Trimethyl nonane	41	—
3,4,7-Trimethyl nonane	34	—
3,5,6-Trimethyl nonane	58	—
3,5,7-Trimethyl nonane	53	—
3,4,4-Trimethyl nonane	31	—
3,5,5-Trimethyl nonane	45	—
3,6,6-Trimethyl nonane	31	—
4,4,5-Trimethyl nonane	57	—
4,4,6-Trimethyl nonane	39	—
4,5,6-Trimethyl nonane	62	—
4,5,5-Trimethyl nonane	63	—
2,2,3,3-Tetramethyl butane	130	130
2,2,3,3-Tetramethyl pentane	115	—
2,2,4,4-Tetramethyl pentane	96	—
2,2,3,4-Tetramethyl pentane	114	—
2,3,3,4-Tetramethyl pentane	121	—
2,2,3,3-Tetramethyl hexane	95	—
2,2,4,4-Tetramethyl hexane	85	—
2,2,5,5-Tetramethyl hexane	78	—
2,2,3,4-Tetramethyl hexane	92	—
2,2,3,5-Tetramethyl hexane	86	—
2,2,4,5-Tetramethyl hexane	86	—
2,3,3,4-Tetramethyl hexane	95	—
2,3,3,5-Tetramethyl hexane	89	—
2,3,4,4-Tetramethyl hexane	95	—
3,3,4,4-Tetramethyl hexane	94	—
2,2,3,3-Tetramethyl heptane	67	—
2,2,4,4-Tetramethyl heptane	82	—
2,2,5,5-Tetramethyl heptane	67	—
2,2,6,6-Tetramethyl heptane	60	—
2,2,3,4-Tetramethyl heptane	82	—
2,2,3,5-Tetramethyl heptane	72	—
2,2,3,6-Tetramethyl heptane	69	—
2,2,4,5-Tetramethyl heptane	82	—
2,2,4,6-Tetramethyl heptane	79	—
2,2,5,6-Tetramethyl heptane	69	—
2,3,3,4-Tetramethyl heptane	83	—
2,3,3,5-Tetramethyl heptane	74	—
2,3,3,6-Tetramethyl heptane	71	—
2,4,4,5-Tetramethyl heptane	88	—
2,4,4,6-Tetramethyl heptane	85	—
2,5,5,6-Tetramethyl heptane	71	—
2,3,4,4-Tetramethyl heptane	88	—
2,3,5,5-Tetramethyl heptane	74	—
2,3,4,5-Tetramethyl heptane	87	—
2,3,4,5-Tetramethyl heptane	84	—
2,3,5,6-Tetramethyl heptane	76	—
2,4,5,5-Tetramethyl heptane	83	—
3,3,4,4-Tetramethyl heptane	88	—
3,3,5,5-Tetramethyl heptane	73	—
3,3,4,5-Tetramethyl heptane	86	—
3,4,4,5-Tetramethyl heptane	91	—
4,4,5,5-Tetramethyl heptane	87	—
2,2,3,3-Tetramethyl octane	46	—
2,2,4,4-Tetramethyl octane	60	—
2,2,5,5-Tetramethyl octane	60	—
2,2,6,6-Tetramethyl octane	46	—
2,2,7,7-Tetramethyl octane	39	—
2,2,3,4-Tetramethyl octane	61	—
2,2,3,5-Tetramethyl octane	61	—
2,2,3,6-Tetramethyl octane	53	—
2,2,3,7-Tetramethyl octane	49	—
2,2,4,5-Tetramethyl octane	67	—
2,2,4,6-Tetramethyl octane	61	—
2,2,4,7-Tetramethyl octane	58	—
2,2,5,6-Tetramethyl octane	61	—
2,2,5,7-Tetramethyl octane	58	—
2,2,6,7-Tetramethyl octane	49	—
2,3,3,4-Tetramethyl octane	63	—
2,3,3,5-Tetramethyl octane	63	—
2,3,3,6-Tetramethyl octane	55	—
2,3,3,7-Tetramethyl octane	52	—
2,4,4,5-Tetramethyl octane	71	—
2,4,4,6-Tetramethyl octane	66	—
2,4,4,7-Tetramethyl octane	63	—
2,5,5,6-Tetramethyl octane	66	—
2,3,4,4-Tetramethyl octane	66	—
2,3,5,5-Tetramethyl octane	66	—
2,3,6,6-Tetramethyl octane	55	—
2,3,4,5-Tetramethyl octane	72	—
2,3,4,6-Tetramethyl octane	67	—
2,3,4,7-Tetramethyl octane	64	—
2,3,5,6-Tetramethyl octane	67	—
2,3,5,7-Tetramethyl octane	64	—
2,4,5,5-Tetramethyl octane	71	—
2,4,6,6-Tetramethyl octane	63	—
2,5,6,6-Tetramethyl octane	63	—
3,3,4,4-Tetramethyl octane	64	—
3,3,5,5-Tetramethyl octane	64	—
3,3,6,6-Tetramethyl octane	53	—
3,3,4,5-Tetramethyl octane	71	—
3,3,4,6-Tetramethyl octane	66	—
3,3,5,6-Tetramethyl octane	66	—
3,4,5,5-Tetramethyl octane	73	—
3,4,5,6-Tetramethyl octane	74	—
4,4,5,5-Tetramethyl octane	73	—

TABLE 2. Calculated octane numbers of the n-olefine hydrocarbons.

n-Olefine hydrocarbons CnH2n	Blending octane numbers Calc.	Obs.
1-Butene	96	111.5
2-Butene	138	—
1-Pentene	97	98.5
2-Pentene	132	125
1-Hexene	78	80
2-Hexene	93	100
3-Hexene	110	—
1-Heptene	61	59.5
2-Heptene	80	—
3-Heptene	95	95
1-Octene	41	38.5
2-Octene	54	55
3-Octene	69	73
4-Octene	83	91
1-Nonene	12	15
2-Nonene	29	—
3-Nonene	45	—
4-Nonene	73	—
1-Decene	−12	—
2-Decene	− 1	—
3-Decene	14	—
4-Decene	44	—
5-Decene	64	—
1-Undecene	−29	—
2-Undecene	−23	—
3-Undecene	−13	—
4-Undecene	5	—
5-Undecene	53	—
1-Dodecene	−43	—
2-Dodecene	−38	—
3-Dodecene	−32	—
4-Dodecene	−21	—
5-Dodecene	6	—
6-Dodecene	41	—

TABLE 3

Hydrocarbon	Dimensions D	D'	D''	Stability factor	Octane numbers (Nash's) Blending value Calc.	Obs.	(Doss') Clear Res.	M. M.
n-Pentane	9 08	3.45	3 18	0 133	55	60	61 7	61.9
n-Hexane	10 34	3 45	3 18	0.103	32	29	24.8	26
n-Octane	12.85	3 45	3.18	0.0664	−18	−19	..	−17
n-Nonane	14.11	3.45	3.18	0.0551	−34	−34	..	−45
2-Methyl butane	7.83	4 04	4 02	0.265	90	92	92.3	90.3
2-Methyl pentane	9 08	3 90	3.81	0.180	72	69	..	73
3-Methyl pentane	9.08	4.34	4 44	0.234	84	84	..	75
2,2-Dimethyl propane	6.57	4.34	5.70	0.573	144	116	..	83
2,2-Dimethyl butane	7.83	4.04	4.86	0.320	100	101	91.8	93.4
2,3-Dimethyl butane	7.83	4.63	4.86	0.367	108	124	0.32	94.3
2,2-Dimethyl pentane	9.08	3.90	4.44	0.210	79	80	..	93
2,3-Dimethyl pentane	9.08	4.79	5.17	0.300	96	94	88.5	83
2,4-Dimethyl pentane	9 08	4.35	4.44	0.234	84	80	..	82
3,3-Dimethyl pentane	9.08	4.34	5 70	0.300	96	98	..	84
2,2-Dimethyl hexane	10.34	3.81	4 19	0.149	62	..	72.5	77.4
3,3-Dimethyl hexane	10.34	4.04	4.86	0.184	73	..	75 5	83.4
2,3-Dimethyl hexane	10.34	4.40	4.52	0.186	73	..	71.3	78.9
2,4-Dimethyl hexane	10.34	4.40	4.52	0.186	73	..	65.2	69.9
2,5-Dimethyl hexane	10 34	4.17	4.18	0.163	67	..	55.5	55.7
3,4-Dimethyl hexane	10 34	4 63	4.86	0.210	79	..	76.3	81.7
3,4-Dimethyl heptane	11.60	4.79	5.07	0.180	72	..	..	56
2,6-Dimethyl heptane	11.60	4.79	5.07	0.180	72	..	..	31
2,2,3-Trimethyl butane	7.83	4.63	5.70	0.430	119	116	1.88	0.07
2,2,4-Trimethyl pentane	9.08	4.35	5.07	0.267	90	100	100	100
2,2,3-Trimethyl pentane	9.08	4.79	5 70	0.331	102	105	1.18	99.9
2,3,3-Trimethyl pentane	9.08	4.79	6.33	0.368	108	..	0.61	100
2,2,3-Trimethyl hexane	10.34	4.40	5.03	0.207	79	..	..	90
2,3,3-Trimethyl hexane	10.34	4.40	5.36	0.221	81	..	..	..
2,3,4-Trimethyl hexane	10.34	4.99	5.36	0.250	82	..	..	..
2,2,6-Trimethyl heptane	11.60	4.05	4.44	0.134	55	..	..	..
2,4,5-Trimethyl heptane	11.60	5.09	5.49	0.208	79	..	..	..
2,4,4-Trimethyl heptane	11.60	4.64	6.12	0.211	79	..	..	..
2,5,5-Trimethyl heptane	11.60	4.20	4.86	0.152	63	..	..	..
1-Butene	6.57	4.30	4.02	0.300	96	111.5	..	80
2-Butene	6.57	5 23	4 44	0.538	138	..	..	83
1-Pentene	7.83	4.39	4 24	0.304	97	98.5	92	..
2-Pentene	7.83	5.84	5.30	0.505	132	125	98	80
1-Hexene	9.08	4.20	4.03	0.250	78	80	80	..
2-Hexene	9.08	5.04	4.59	0.281	93	100	89	78
3-Hexene	9.08	5.84	5.30	0.375	110	..	97	..
2,2,3,3-Tetramethyl butane	7.83	4.63	6.54	0.494	130	130	130	103
1-Heptene				0.0789—0.0879			54	
3-Octene				0.139—0.172			72.5	
2-me-5-hexene				0.219—0.250			82	
2,4-Dime 2-pentene				0.586—0.738			>100	
2,3-Dime 2-pentene				0.594—0.745			127 bbl	
2-me-2-butene				0.691—0.887			98	

Furthermore, if we take (S + 4) rich, supercharged blending values obtained for various pure hydrocarbons, we can plot them as in Fig. 3, where separate curves are obtained for aromatics, paraffins, and olefins, the different positions of the curves apparently being due to varying lead susceptibilities, for these are heavily leaded blends, in contrast to the clear fuels shown in Fig. 2. The dimensional data on structures of the aromatics were obtained roughly by measuring Fischer-Hirschfelder models, and hence they are not comparable with Kobayasi's figures, nor very accurate. It will be observed that o-xylene shows a wide discrepancy in this particular tabulation. Other hydrocarbons that do not conform to the curves are n-butane and 2,2 dimethyl pentane.

It will also be observed that the leaded (supercharged, rich) blend curves are similar in nature to the curve for clear fuels (Fig. 2), the equation for which has been calculated to be:

$$O.N. = 294.7\ (10\alpha\beta\gamma)^{0.167} - 257$$

Several years ago, Mibashan[4] described an empirical relationship between octane number and "centralization" index, which is related to chemical structure. Fig. 4 shows how Kobayasi's stability index compares with this centralization index for a number of paraffins and olefins. There appears to be a definite correlation.

While on the subject of lead susceptibility, it might be mentioned that there appears to be a rough correlation between the ratio of density to surface tension (d/T) with this property. As can be seen from Fig. 5, the relationship appears to be a straight line.

References.

1. Gaylor, *The Petroleum Engineer*, December, 1946, p. 790.
2. Kobayasi, *J. Soc. Chem. Ind.* (Japan) April, 1937, (Supplement), p. 153B, June, 1937, p. 219B, September, 1937, p. 317B.
3. Ibid. October, 1937 p. 341B.
4. *Refiner*, July 1943. p. 28.

★ ★ ★

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Plotting back pressure open flow curves

By **W. F. MARTIN,** Texoma Natural Gas Company

THE back pressure method of computing open flows of gas wells is a widely accepted method. It is also the official method of Texas, and perhaps it is official for several other states. This method, however, entails complicated calculations, or the use of several tables from which to obtain factors for comparatively simple computations.

EXCLUSIVE

The writer devised a computing chart from which all factors for computations involved in obtaining curve points could be readily obtained. This chart (p533.401.1) was published in *The Petroleum Engineer* in the "Continuous Tables" section in July, 1944. The explanation of this chart at that time, however, was rather brief, and it was attempted to show all the steps involved in the various computations with one illustration. It is now thought that a further, and more detailed, explanation should be made, accompanied by appropriate sketches, or exhibits. Each exhibit will be treated separately herein in an attempt to show the simplicity of the chart and to bring out clearly that all information needed to plot back pressure open flow curves is, or can be, embodied in an 8½-in. by 11 in. chart.

Exhibits A and A-1: This is the well test data sheet (two sides). It is presented herein to show what is required for the computation of curve points. Requirements are: R; friction drop; P_1; F; P_s; and P_f. It also sets out the conditions under which computations are made.

Exhibit B: This exhibit deals with R, friction drop, and P_1. The first step is to ascertain "R." Referring to the exhibit, there will be observed a point for gravity and a point for depth (depth of well). These points are above the regular cross-section portion of the chart. A line drawn from the lower left-hand corner of the lower section of the chart through the intersection of the gravity and depth points crosses the "10" horizontal line of lower section at "R" for 10 MM cu. ft. of gas. If this line is followed down to the quantity of gas shown in the test represented by the vertical scale, "R" for that quantity will be observed. If a line is drawn from lower left-hand corner of chart through the intersection of P_2 and R, and this line is followed to topmost scale, the friction drop in per cent of P_2 will be observed. P_2 multiplied by this reading results in friction drop in pounds per square inch, which added to P_2 becomes P_1.

Exhibit C: This exhibit deals with F. There is a double scale above the lower portion of the chart, one side of which represents P_2/P_1, whereas the other side represents F. A line drawn from the lower left-hand corner of the chart to a point on P_2/P_1 permits the F factor to be read for that particular point. We are now in possession of all elements that make up the GLF factor.

Exhibit D: This exhibit deals with the weight of gas column and P_s, as well as P_f. At the right hand side of lower section of the chart is another double scale, one side of which represents GLF, and the other side represents weight of gas column in per cent of P_1, or, if the well is shut in, in per cent of P_2. A line drawn from the lower left-hand corner of the lower section of the chart through a point on the GLF scale permits the reading of the weight of the gas column for that particular GLF in per cent of P_1. P_1 multiplied by this reading results in weight of gas column in pounds per square inch, which added to P_1 becomes P_s. In the case of a shut-in well, P_2 is used instead of P_1. P_2 plus column

EXHIBIT A.

Back pressure capacity test.

..... Original calculation.
..... Check calculation.
..... Any other calculation.

Well name.....Well No.....
Date.....19.....
Location.....
Sec.....Blk.....Survey.....
.....County.....

8⅝-in. casing at 2307. Gas pay 2367 to 2995. Total depth 3006.
171 feet 5-in. liner 3006.
574 feet of 7-in. liner bottom set at 2850.

Spec. grav. (G)	0.705	No. of days well shut-in	3
Aver. depth (L)	2681	Shut-in pressure at wellhead (ga.)	267.4
GL	1890	Shut-in pressure at wellhead (abs.)	280.4
Curve coeff (C)	.... Log C.....	Weight of static column (lb. per sq. in.)	.....
Curve slope (n)	....	Shut-in pressure at sand face (Pf)	299.4

Calculating rates of flow

	Pressure at prover		Pipe line meter		Quantity, M. cu. ft. per 24 hr. at 16.4 lb. 60°F. base Actual gravity					
	Gauge	Absolute	L-10 diff.	L-10 press.	Orifice, size, in.	Coeff. 4-in.	Gravity factor	Temp., °F.	Temp. factor	Quantity, M. cu. ft.
1	252.1	265.1	..	..	1	15.26	1.1910	76	0.9850	4,746
2	241.5	254.5	..	..	1¼	23.73	1.1910	76	0.9850	7,079
3	225.6	238.6	..	..	1½	34.05	1.1910	76	0.9850	9,531
4	207.5	220.5	..	..	1¾	46.51	1.1910	76	0.9850	12,030
5										

Calculating curve data

	W. H. pressure (gauge)	W. H. pressure abs. (P_2)	R/MM 3.89 R	Frict. drop, psi	W.H.+ frict. (P_1)	$\frac{P_2}{P_1}$	F	GLF	Wt. col. psi	Pressure at sand face	P^2_s(M's)	P^2_f 89.64 Diff. sq.
1	253.3	266.3	18	.6	266.9	0.998	0.9990	1888	....	285.0	81.23	8.41
2	242.2	255.2	28	1.5	256.7	0.994	0.9970	1884	....	274.0	75.08	14.56
3	227.8	240.8	37	2.8	243.6	0.989	0.9945	1880	....	260.0	67.60	22.04
4	210.1	223.1	47	4.8	227.9	0.979	0.9895	1870	....	243.2	59.15	30.49
5												

Date	Rock pressure	BPOF MM. cu. ft.	Slope "n"	Remarks
10-28-46	267.4	26.2	0.715	

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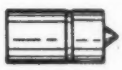
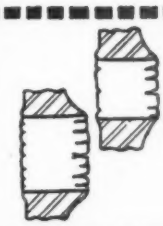
	BURRFREE for all jobs where smooth inner surface of pipe is necessary and a slight reduction in penetration is not vital. 	Smooth inner pipe surface. Less penetration than with Steelflo.
	SEMI-MUSHROOM FULL-MUSHROOM for casing removal and cement fracturing.	 Holes larger than bullet. Less penetration than Steelflo.
	NEEDLE for establishing circulation in stuck tubing or other purpose where small orifice is desired.	Hole same size as bullet. Reduced burr.
	PUNCH for perforating the inner of two strings.	**NEGLIGIBLE BURR** Hole same size as bullet.

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EXHIBIT B. Problem 1. Part 1.

The straight lines indicate this problem.

2.15% of $P_2 = 4.8$ psi.

$223.1 + 4.8 = 227.9 = P_1$

EXHIBIT C. Problem 1. Part 2.

The dashes on the drawing shows this problem.

$G = .705$

$L = 2681$

$F = .9895$

$GLF = 1870$

EXHIBIT D. Problem 1. Part 3.

Dotted line shows this problem.

$P_1 = 227.9$

6.705 of 227.9 = 15.3 psi.

$227.9 + 15.3 = 243.2 = P_S$

NOTE: Shut-in wellhead pressure is 280.4 psia.

GL=1890. F=1.0 Pf=106.76 per cent of 280.4 or 299.4 lb.

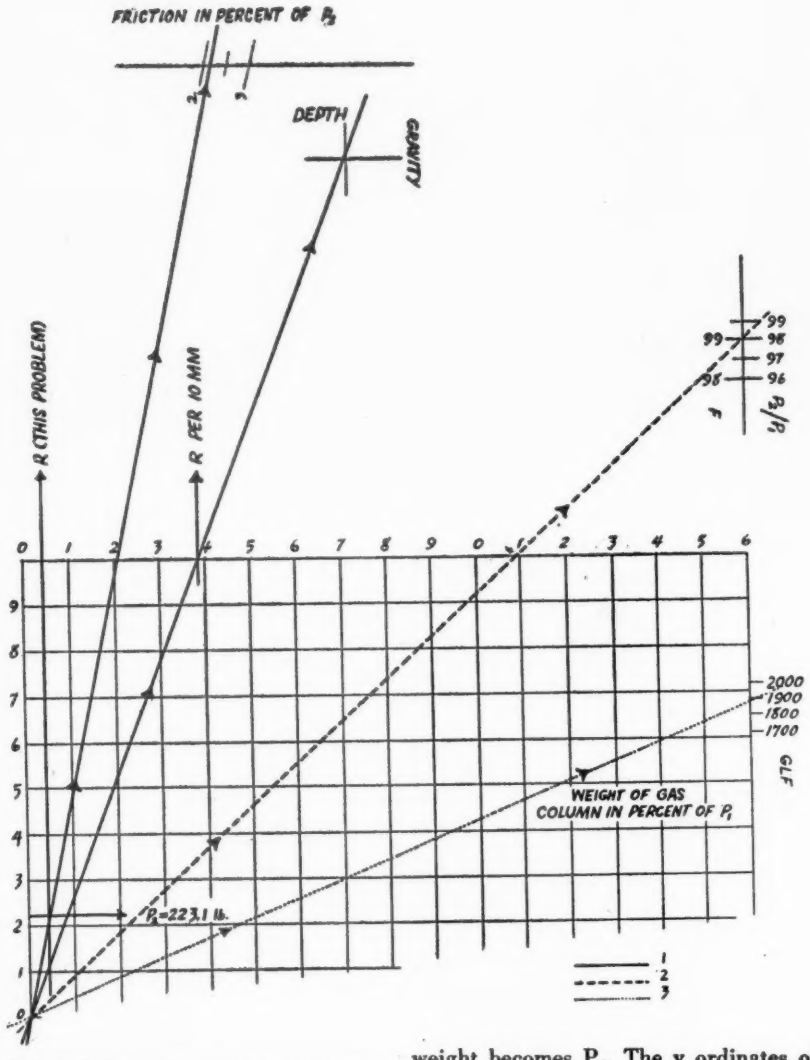

EXHIBIT A-1. Field data for back pressure capacity test.

..... Gas engineer. Well name..... Well No.....

..... Witness. Date..... 19.....

..... Railroad Commission or otherwise. Remarks for blowing well:

Back pressure field data.

4-in. prover set on W. H.

	Start time		Finish time		Time to stab.		Size Disc., in.	Meter		Pressures		Temp., °F.
	Date	Hour	Date	Hour	Hr.	Min.		L-10 Diff.	L-10 Prover	W. H.	Prover	
	1946		1946									
1	10-28	2:40 P	10-29	3:45 P	25	05	1			253.3	252.1	76
2	10-29	3:50 P	10-30	1:10 P	21	20	1¼			242 2	241.5	76
3	10-30	1:20 P	10-31	11:45 A	22	25	1½			227.8	225.6	76
4	10-31	11:50 A	11- 1	3:15 P	27	25	1¾			210.1	207.5	76
5												

Field data for pitot tube capacity test.

Specific gravity test

Date..... 19.....

Actual gravity.....

Correction factor.....

Rock pressure data

Acres assigned to well.....

Number of days well shut-in.....

Rock pressure.....

Pilot tube open flow

..... Last previous test	Present test				
Date	Time	Impact pressure	Unit	Size opening	Reid table vol., M. cu. ft.
Days shut-in	M.				
Rock pressure	M.				
Pilot open flow (16.4 lb.)	M.				
	Volume corr. to act. grav., 14.65 lb.				
	Volume corr. to act. grav., 16.4 lb.				

weight becomes P_t. The y ordinates of the curve are log $(P_t^2 - P_s^2)$ in thousands, and the x ordinates are log Q (Quantities) in millions of cubic feet of gas. Only the fourth calculation shown on Exhibit A is used for this discusssion.

Exhibit E: This exhibit shows the complete chart, whereas other exhibits show only the parts needed for their particular parts of the problem.

It is believed that the construction of all scales on this chart, except perhaps the special scales for "L in M Ft" and "Gravity," are obvious. Therefore, the discussion on construction will be confined to them. Their purpose is to ascertain "R," and $R = Q(GL)^{1/2}/K$.

$K = 42{,}990\ d^{8/3}$, and "d" = diameter of the producing string of casing.

G = Gravity and L = average depth of pay sand. Let Q = 1.

When Q = 1., $R = (GL)^{1/2}/K$, and $(GL)^{1/2}/K = (L)^{1/2}/[K/(G)^{1/2}]$. Therefore, the vertical scale is $K/(G)^{1/2}$ and the horizontal scale is $(L)^{1/2}$. By placing straight-edge at lower left-hand corner of lower section of chart and at the intersection of "L in M Ft" and "Gravity," we divide $(L)^{1/2}$ by $K/(G)^{1/2}$, reading the quotient on the "10" horizontal line of lower section of the chart; and, without moving straight-edge, any multiplier can be applied.

$P_1 = (P_2^2 + R^2)^{1/2}$. After "R" is ascertained, it becomes one side of a triangle, P_2 the other side, and the hypot-

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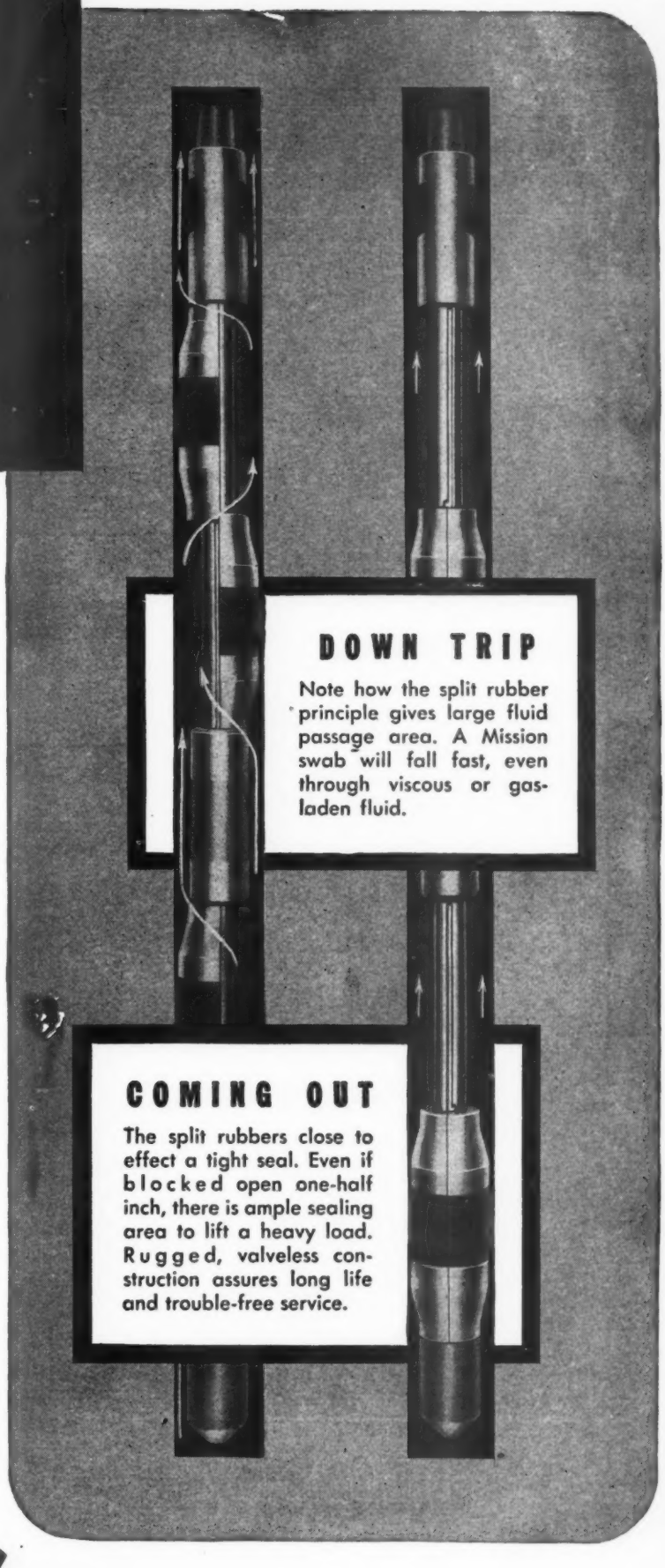
DOWN TRIP
Note how the split rubber principle gives large fluid passage area. A Mission swab will fall fast, even through viscous or gas-laden fluid.
COMING OUT
The split rubbers close to effect a tight seal. Even if blocked open one-half inch, there is ample sealing area to lift a heavy load. Rugged, valveless construction assures long life and trouble-free service.

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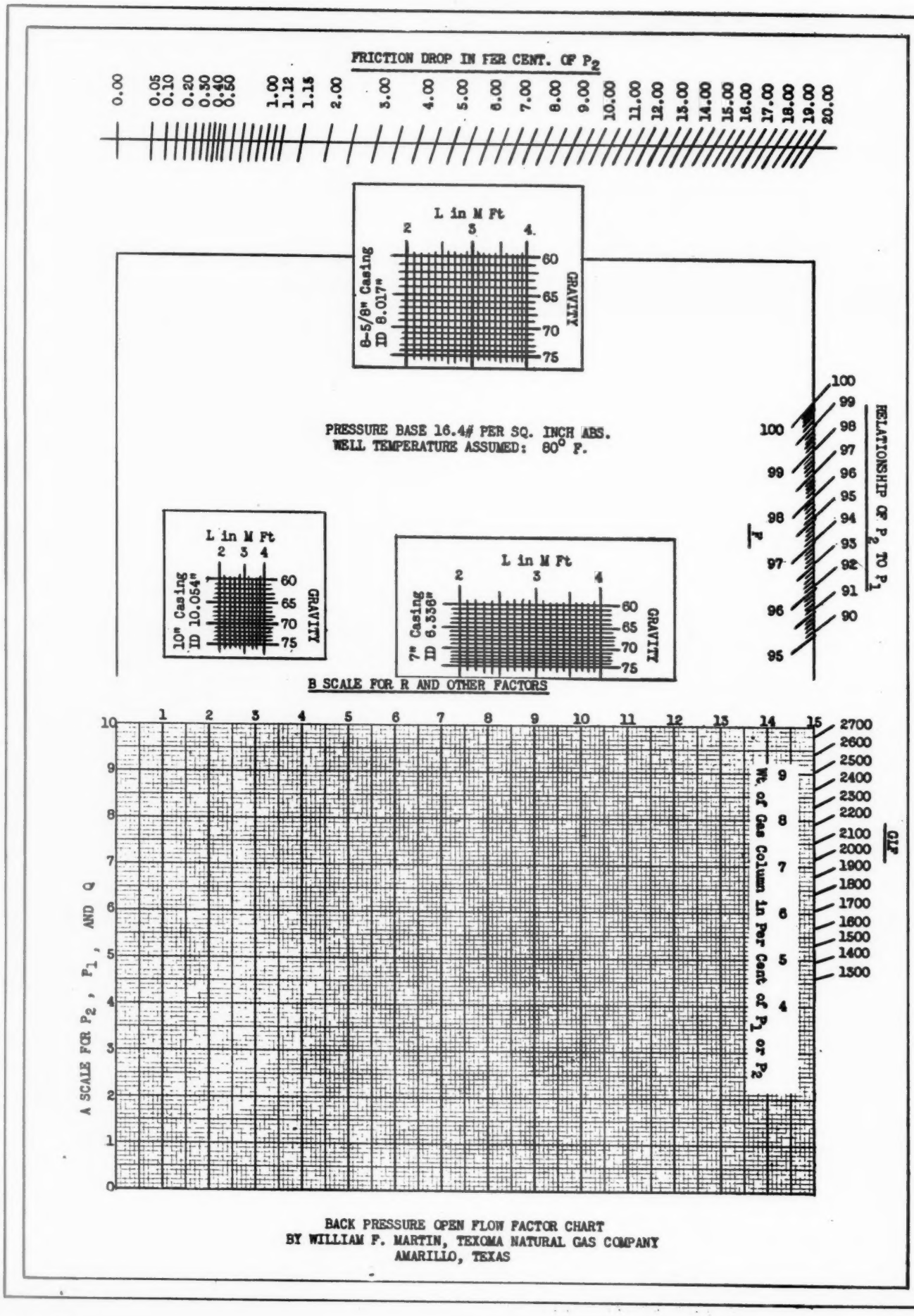
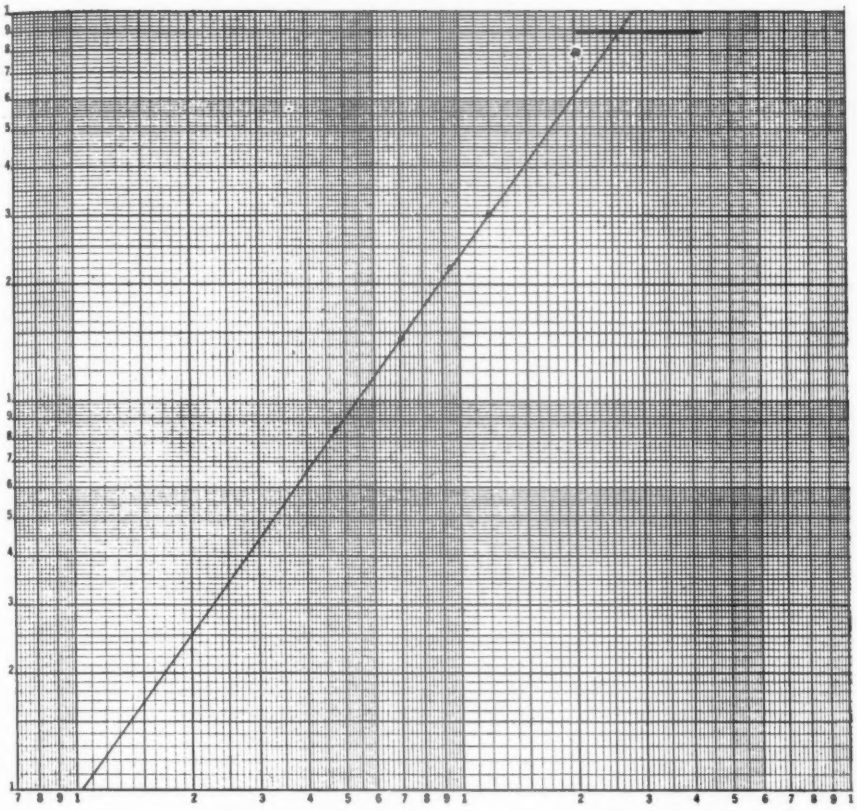
EXHIBIT E



BACK PRESSURE OPEN FLOW FACTOR CHART
BY WILLIAM F. MARTIN, TEXOMA NATURAL GAS COMPANY
AMARILLO, TEXAS

EXHIBIT F

Plotted curve on logarithmic scale.



enuse is P_1. It is obvious that the Scale "Friction Drop in Per Cent of P_2" is a convenient arrangement to read small increases in pressure in per cent of P_2, it being the hypotenuse of the triangle in per cent of P_2 minus 100 per cent.

Exhibit F: This is the plotted curve on logarithmic scale. From it, the slope of the curve, the curve coefficient, and the open flow of the well are ascertainable. The calculation is $\log Q = \log C + n[\log (P_f^2 - P_s^2)]$.

In the case of open flow, P_s is atmospheric pressure; is therefore negligible.

The field data on Exhibit A is worked out by means of chart (Exhibit E) and the results are plotted on Exhibit F.

It is believed that much time can be saved without loss of accuracy by the use of a chart of this kind. Charts can be prepared to suit a company's conditions by their gas engineers, using the one illustrated as a model if it is so desired.

As for accuracy, the factors appearing on data sheet shown as Exhibit A were taken from tables, and were checked by chart manipulation.

The lines drawn from lower left-hand corner of the chart represent the center line of an arm of transparent material pivoted at the lower left-hand corner of the chart.

The lower section of the chart also provides a multiplying and dividing device that can be used with the same facility and accuracy as a slide rule. ★★

P 420.31

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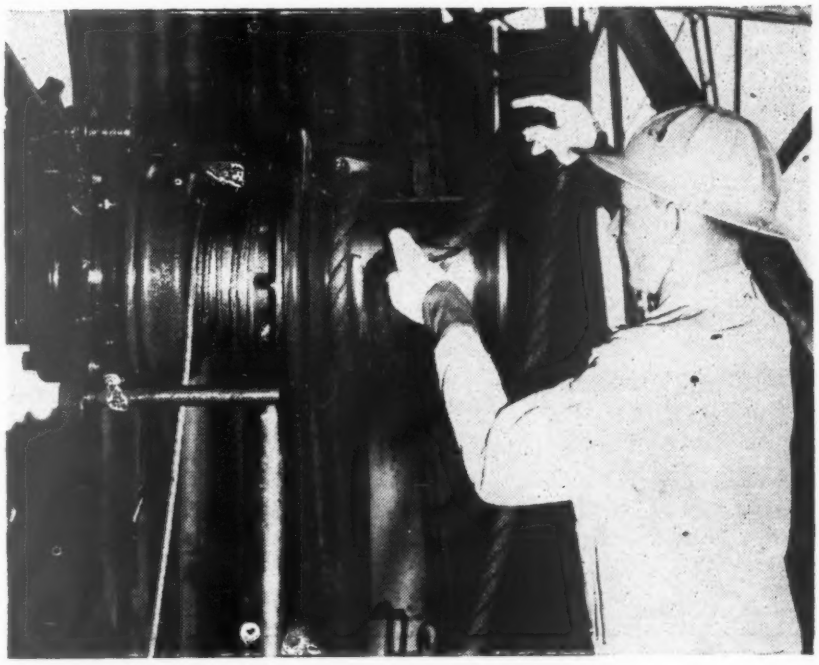
The 1¼-in. solid steel rod was heated and bent to the shape of the cathead for three quarters of the circumference and with a slight offset amounting to the diameter of the catline. With a clearance of approximately ⅛ in. between the cathead and bent bar, the piece was permanently mounted to the frame of the drawworks with a straight section of the same rod material. The free end of the rod was rounded off and smoothed.



Guard on cathead helps to keep line from overlapping.

The action of the permanently mounted rod is to space the turns of the catline so that the second turn of line on the cathead has little chance of overlapping the first. The free end is also kept at a safe distance from the running end of the line and reduces chances for fouling. ★★★

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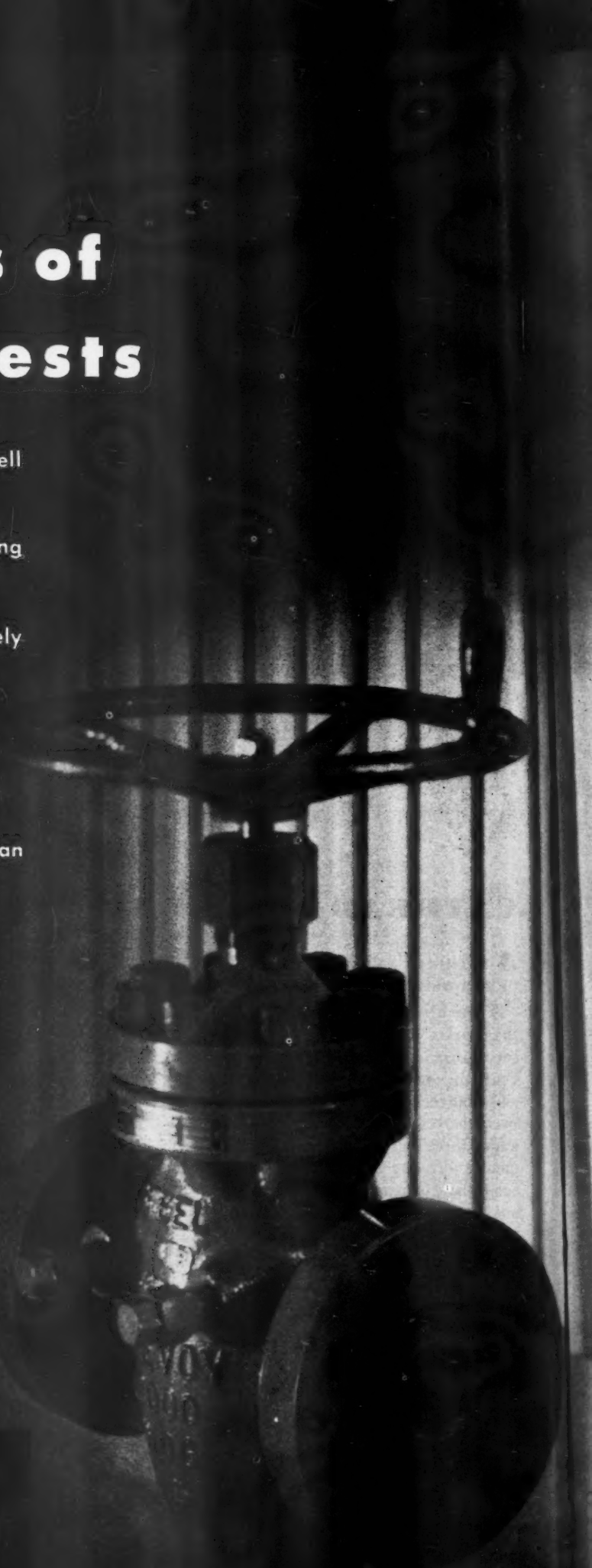

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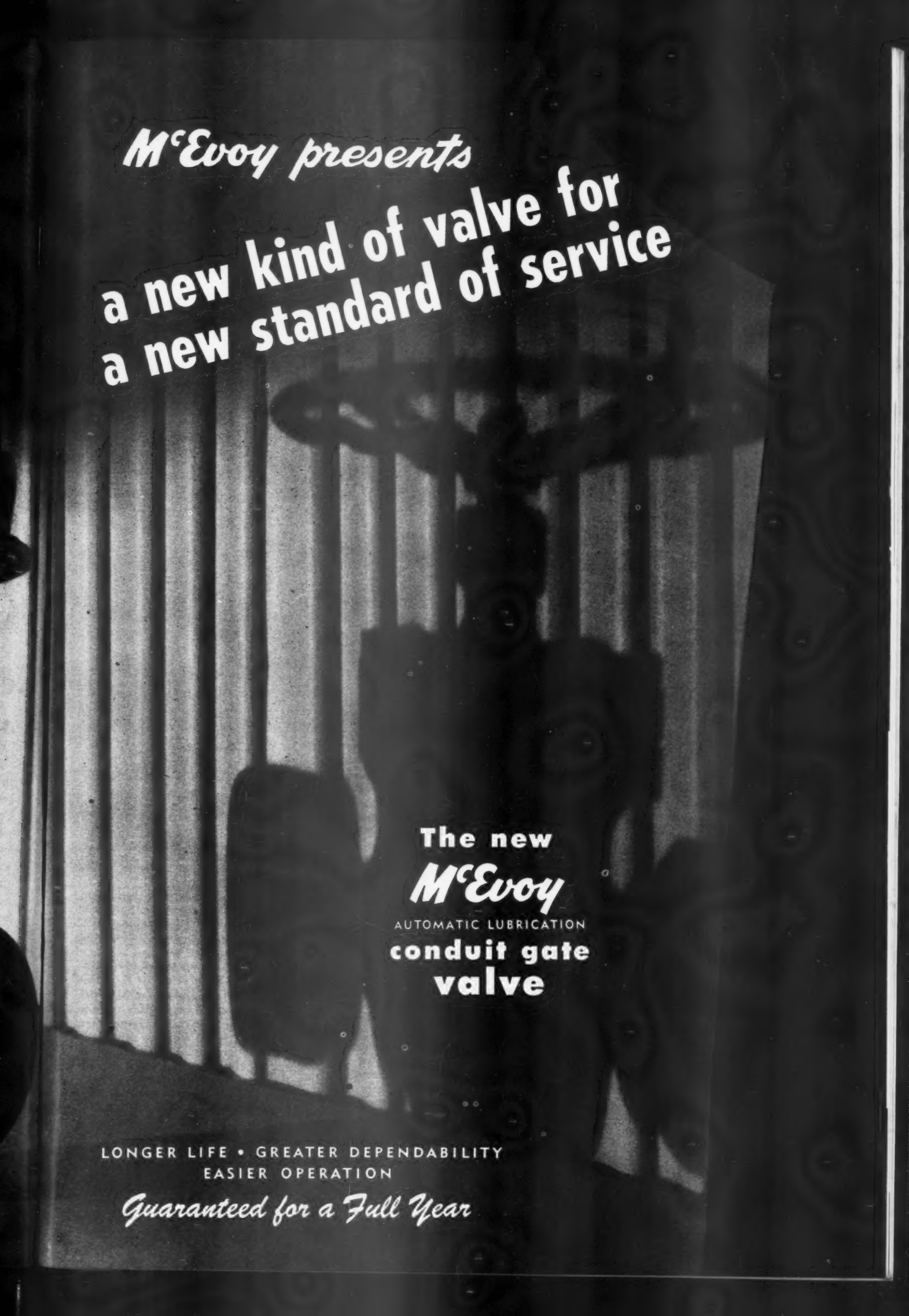
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Calculations of bottom-hole pressures

By **FRANK C. FOWLER,** School of Chemical Engineering, University of Oklahoma

THREE methods of calculating bottom-hole pressure are discussed and compared by Rzasa and Katz[5] with an actual bottom-hole pressure measured in a gas well[2]. All three methods require a trial and error solution. Two of the three methods presented assume an average fluid density equal to the density of the fluid at the average temperature and pressure in the well. The remaining method takes into account the variation of compressibility factor with temperature and pressure throughout the well bore. This method is the most accurate of the three but is also the most time consuming.

EXCLUSIVE

A method involving a direct solution and obviating the trial error solution for calculating bottom-hole pressure is presented in this article. The accuracy of this method is comparable to the two shorter methods given in the article by Rzasa and Katz[5].

● **Derivation of equation.** In a column of fluid of uniform composition, the following differential equation can be applied to the change in pressure, dP, over a height of fluid, dh, having density, ρ:

$$dP = \rho dh \quad \ldots\ldots\ldots \quad (1)$$

Using compressibility factors, the density, ρ, can be expressed as:

$$\rho = \frac{MP}{ZRT} \quad \ldots\ldots\ldots \quad (2)$$

Where:

ρ = density, lb per cu ft,
M = molecular weight of fluid,
P = pressure, psf,
R = 1544 psfa, cu ft per lb mole, °R,
T = absolute temperature, °F + 460, and
Z = compressibility factor.

Substituting equation (2) into equation (1):

$$dP = \frac{MPdh}{ZRT} \quad \ldots\ldots\ldots \quad (3)$$

Rearranging and integrating equation (3):

$$\int_{P_1}^{P_2} \frac{ZTdP}{P} = \frac{(h_2 - h_1)\,M}{R} \quad \ldots \quad (4)$$

$(h_2 - h_1)$ represents the length of fluid between pressures P_2 and P_1.

For simplification, $(h_2 - h_1)$ will be replaced with h representing the height or depth of fluid in the well.

Removing the temperature, T, from the integral by replacing it with the proper average temperature T_a, equation (4) becomes:

$$\int_{P_1}^{P_2} \frac{ZdP}{P} = \frac{hM}{RT_a} \quad \ldots\ldots \quad (5)$$

Equation (5) can be graphically integrated by using compressibility charts. As compressibility charts are customarily placed on a general basis of reduced temperature and pressure, there is no reason why the above integration cannot be carried through on the same general basis.

By definition:

$$P_r = \frac{P}{P_c} \quad \ldots\ldots\ldots \quad (6)$$

Where:

P_r = reduced pressure,
P_c = critical pressure of fluid (abs), and
P = pressure of fluid (abs).

From equation (6):

$$dP = P_c dP_r \quad \ldots\ldots\ldots \quad (7)$$

Substituting equations (6) and (7) into equation (5):

$$\int_{P_{r,1}}^{P_{r,2}} \frac{ZdP_r}{P_r} = \frac{hM}{RT_a} \quad \ldots\ldots \quad (8)$$

Integration of equation (8) has been completed graphically, using compressibility factors for methane published by Brown[1]. This integration has been carried out between pressure limits of $P_r = 0.2$ and P_r extending to a value of 12 for constant reduced temperatures between 1.0 and 2.5. The results are shown in Fig. 1. The choice of the lower pressure limit $P_r = 0.2$ was purely arbitrary and any other value might have been chosen. The integral used is between limits so that absolute values from zero pressure are not necessary.

Although a rigorous solution indicates that the arithmetic average of wellhead and bottom-hole temperatures is not strictly the proper average, the error introduced by this type of average is generally small. The temperature gradients of shut-in gas wells have been reported in the literature. The gradients are essentially linear after a depth of 2000 ft has been exceeded. Temperature gradients vary with different fields. Two typical gradients are presented in Fig. 2. One is taken from the article of French[3] for the Wasco field, California, and the other is from the article of Eilerts and Schellhardt for a well in the East Texas field.

● **Application of equation.** To illustrate the application of equation (8) and Fig. 1 to an actual calculation of the bottom-hole pressure, well data from an article by Eilerts and Schellhardt are used. The well depth is 7500 ft with a shut-in temperature gradient shown in Fig. 2 as the East Texas well. The specific gravity of the gas is 0.744 (referred to air) and its composition such that the pseudo-critical temperature and pressure were 386 F and 664 psia, respectively. Pressure at the wellhead is 2500 psia.

● **Solution:** The method of determining the average temperature in the well will affect the calculated pressure. Rzasa and Katz[5] used the arithmetic average of the wellhead and bottom-hole temperatures. This average temperature equals:

$$\frac{76 + 228}{2} = 152 \text{ F}$$

Referring to Fig. 2, it can be seen that the true average temperature is higher than 152 F. This true average can be obtained by calculating the area between the curve and the ordinate of well depth and dividing it by the depth of the well. Since the abscissa begins at 40 F in Fig. 2, care must be exercised so that the area between 0 F and 40 F is not omitted. The average well temperature calculated in this manner is 168 F. To emphasize the importance of obtaining reliable temperature gradients, the bottom-hole pressure is determined for both average temperatures.

Mol weight of gas:

$$M = 0.744\ (28.9) = 21.5$$

$$P_{r,1} = \frac{2600}{664} = 3.92$$

Using average temperature of 152 F:

$$T_r = \frac{152 + 460}{386} = 1.59$$

From equation (8):

$$\int_{P_{r,1}}^{P_{r,2}} \frac{ZdP_r}{P_r} = \frac{21.5\ (7500)}{1544\ (612)} = 0.171$$

Interpolation between $T_r = 1.5$ and $T_r = 1.6$ for $T_r = 1.59$ in Fig. 1 gives:

$$\int_{0.2}^{3.92} \frac{ZdP_r}{P_r} = 2.78$$

Therefore:

$$\int_{0.2}^{P_{r,2}} \frac{ZdP_r}{P_r} = 2.78 + 0.171 = 2.95$$

From Fig. 1:

$$\int_{0.2}^{P_{r,2}} \frac{ZdP_r}{P_r} = 2.95 \text{ at } P_{r,2} = 4.82$$

Thus the bottom-hole pressure = 4.82 (664) = 3200 psia.

This value of 3200 psia for the bottom-hole pressure compares favorably with the experimental measured value of 3192 psia and is as accurate as the two shorter methods of Rzasa and Katz[5].

Using an average temperature of 168 F, a value of 4.76 is obtained for $P_{r,2}$. This gives a bottom-hole pressure of 3160 psi. Normally one would expect this value to be closer to the measured pressure than the value calculated with the arithmetic average temperature of 152 F. Before a definite conclusion can be made regarding the type of average temperature to be used in equation (8), additional comparisons between calculated and carefully measured pressures should be made. Pressure measurements must be made after the well is shut-in for a period sufficient to establish reliable measurements. A second shut-in test on the well

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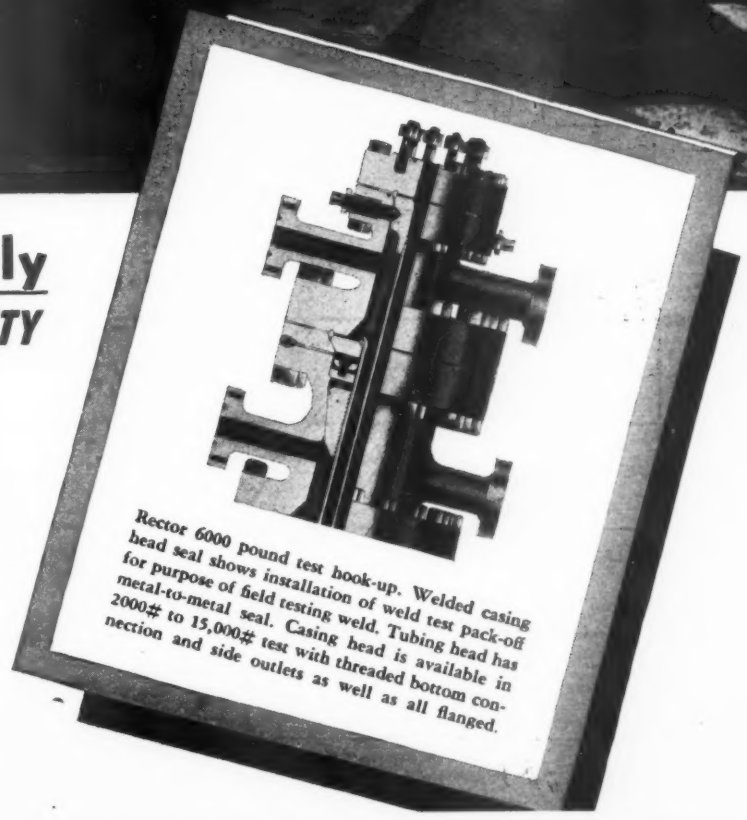

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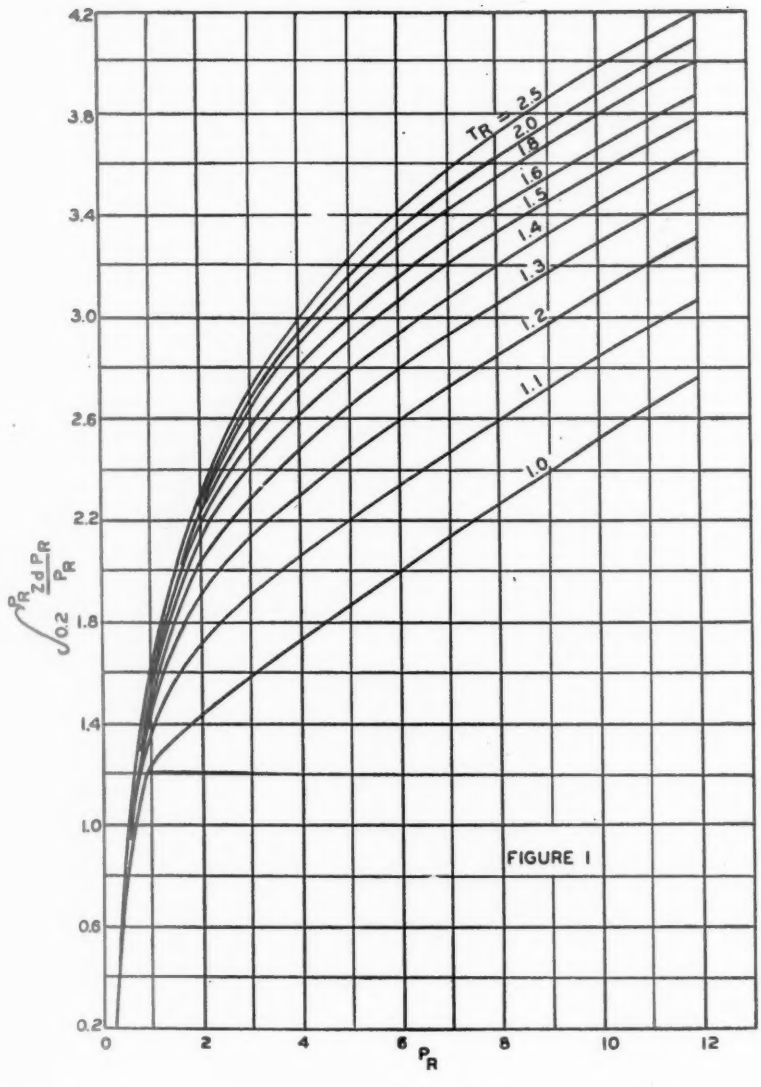


FIGURE 1

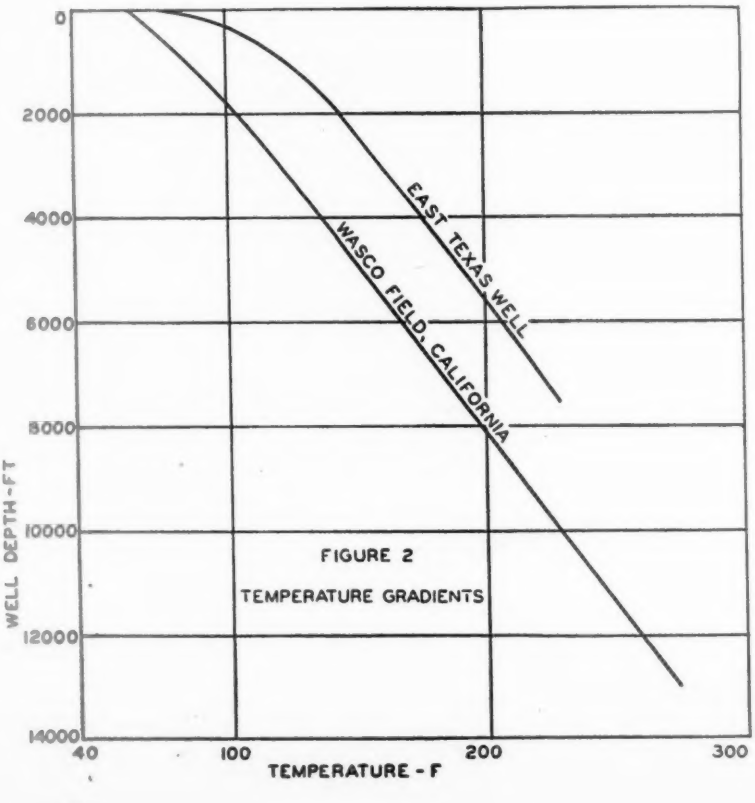


FIGURE 2

TEMPERATURE GRADIENTS

reported by Eilerts and Schellhardt[2] shows a wellhead pressure of 2580 psi and a bottom pressure of 3139 psi. In case of the second test, the true average well temperature gives a closer agreement between calculated and measured pressures.

Although $\int_{P_1}^{P_2} \frac{ZdP}{P}$ has been determined specifically for calculating pressures in gas wells, it may prove useful in other types of problems. One example occurs in determining the horsepower for isothermal compression. The theoretical work required by a compressor is equal to the $\int_{P_1}^{P_2} VdP$. If the compression is isothermal, the $\int_{P_1}^{P_2} VdP$ is equal to $\frac{RT}{M} \int_{P_1}^{P_2} \frac{ZdP}{P}$. This integral can be determined from the differences between the values of the integral at the suction and discharge pressures read from Fig. 1.

● **Conclusions.** Equation (8), when used in conjunction with Fig. 1, will yield a direct solution to bottom-hole pressure computations that have an accuracy comparable to trial-error methods[5].

For best results, the well information necessary for such calculations includes wellhead pressure, well depth, temperature gradient of well, and gas composition. If gas composition is not known, the gravity can be used to obtain the pseudo-critical temperature and pressure[4,6].

The importance of obtaining the correct average well temperature is seen in the example calculations. A difference in average temperature determinations of 16 F results in 6.7 per cent variation in the calculated $\triangle P$ for the example cited[2].

Nomenclature.

h = well depth, ft,
M = molecular weight of gas,
P = pressure, psfa,
P_c = critical pressure of gas, psfa,
P_r = reduced pressure, $\frac{P}{P_c}$,
R = gas constant, 1544 psfa, cu ft per lb mole, °R,
T = temperature, °R = °F + 460,
T_a = average temperature in well bore, °R = °F + 460,
T_c = critical temperature of gas, °R = °F + 460,
T_r = reduced temperature, $\frac{T}{T_c}$,
V = volume of gas at temperature, T, and pressure, P,
Z = compressibility factor for gas at temperature, T, and pressure, P, and
ρ = density of gas, lb per cu ft.

Literature cited.

1. Brown, *The Petroleum Engineer*, *11*, No. 4, 21 (1940).
2. Eilerts and Schellhardt, *U. S. Bureau of Mines, R. I.* 3402 (1938).
3. French, *Oil and Gas Journal*, *37*, No. 50, 43 (1939).
4. Katz, *Ref. and Nat. Gasoline Mfr.*, *21*, No. 6, 58 (1942).
5. Reasa and Katz, *A.I.M.E. Transactions*, *160*, 113 (1945).
6. Standing and Katz, *A.I.M.E. Transactions*, *146*, 140 (1942).

★ ★ ★

Sampling two-phase streams from high pressure condensate wells*

By **DONALD L. KATZ** and **GEORGE GRANGER BROWN,** University of Michigan

In 2 parts—PART 1

THE natural gas flowing from a high pressure condensate well carries with it liquid condensate. The problem is to obtain a representative sample of this total stream, containing aliquot portions of the gas and liquid, so that the sample will possess the same total composition as that of the total material (gaseous and liquid) flowing from the well. The most reliable procedure for obtaining a sample of aliquot portions of gas and liquid, is to flow the entire stream through a full scale separator and measure the rate of flow of dry gas and liquid separately. Samples of these two streams may then be combined in the proportion in which they were flowing. This full scale sampling offers certain disadvantages which make it undesirable both for wells producing to a cycling plant and for isolated wells.

Full scale separator equipment is not readily portable and can be moved to an isolated well only at considerable expense. With the full scale equipment large quantities of residue gas and liquid condensate must be disposed of, either by return to the gathering system or by venting. This is not always practical. When returning residue gas or liquid condensate to a gathering system it is necessary to limit the pressure of the full scale separator to the line pressure of the gathering system. At these high pressures the residue gas from the separator may become a two-phase stream upon any further reduction in pressure. This condition makes it extremely difficult if not impossible to handle the gas sample in a manner to insure the correct recombination with the liquid sample.

In many cases it is desirable to make the tests on two-phase streams always at the same temperature and pressure for purposes of comparing liquid contents.

It is impossible to do this with a full scale separator unless elaborate equipment is available for controlling the separator temperature.

Because of these disadvantages of the large or full scale separator it is desirable to use a small scale sampling device which is readily portable and can be used in much the same manner as the usual test car for determining gasoline content. Sampling procedures for two-phase streams involve the insertion of a tip of some kind into the flowing fluid and the removal through this tip of a small portion of the stream. Fig. 1 indicates such a tip inserted in a horizontal pipe and used with a small scale separator. The full scale separator is used as a standard for the purpose of calibrating the small scale sampling procedure. For any particular installation and flow conditions the only variable controlling the proportion of the gas and liquid in the sample, is the velocity with which the sample is withdrawn through the tip. Fig. 2 shows the effect of the sampling rates on the liquid content of the small scale sample. These data were taken under constant steady flowing conditions in the full scale stream and the only condition which was varied was the rate at which the sample was withdrawn through the tip.

The characteristics shown in Fig. 2 are those of any sampling tip. An increase in the rate with which the sample

*Presented before Natural Gasoline Association of America, Dallas, Texas, April 18, 1946.

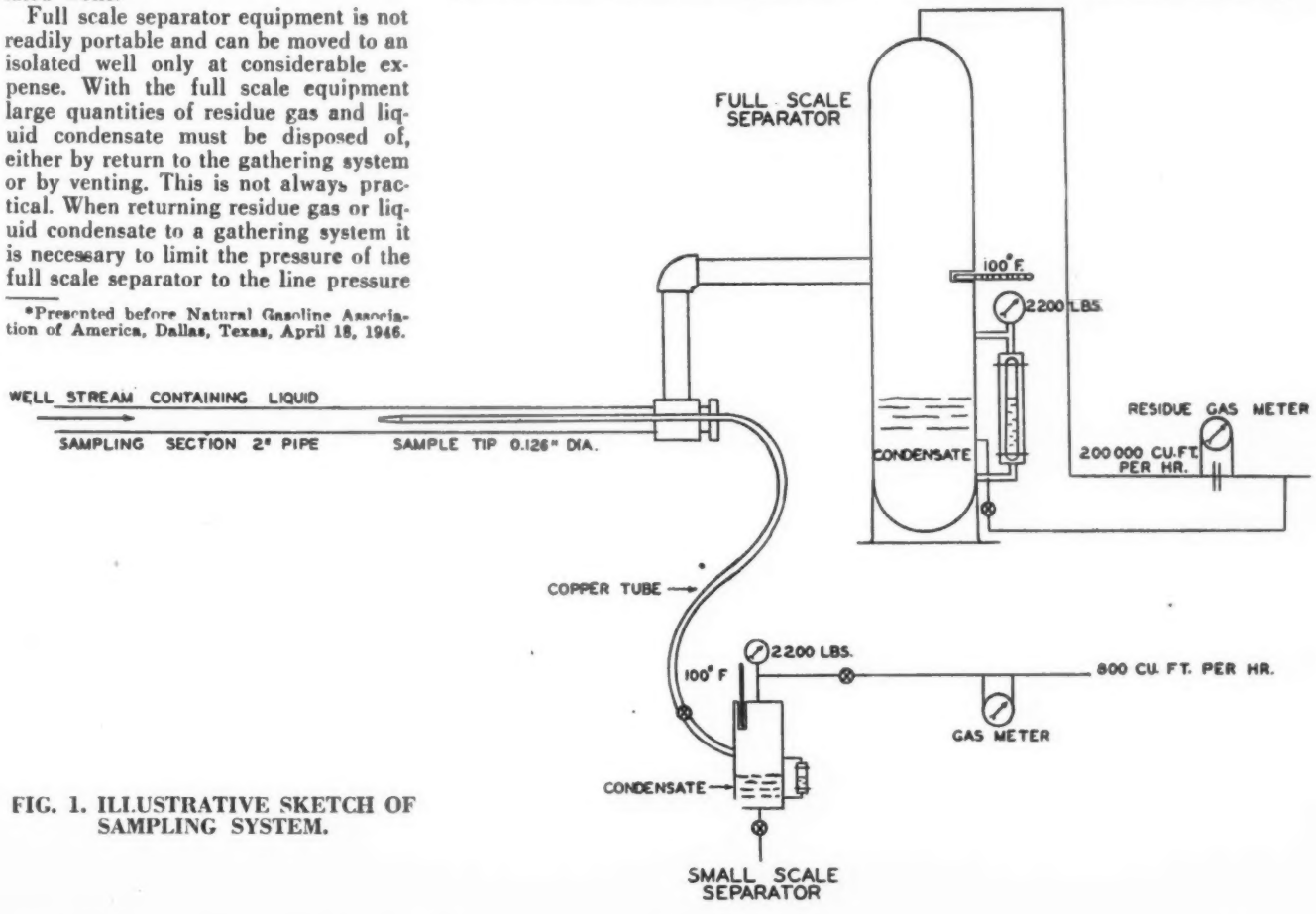


FIG. 1. ILLUSTRATIVE SKETCH OF SAMPLING SYSTEM.

FIG. 2. Effect of sampling rate on liquid content of sample.

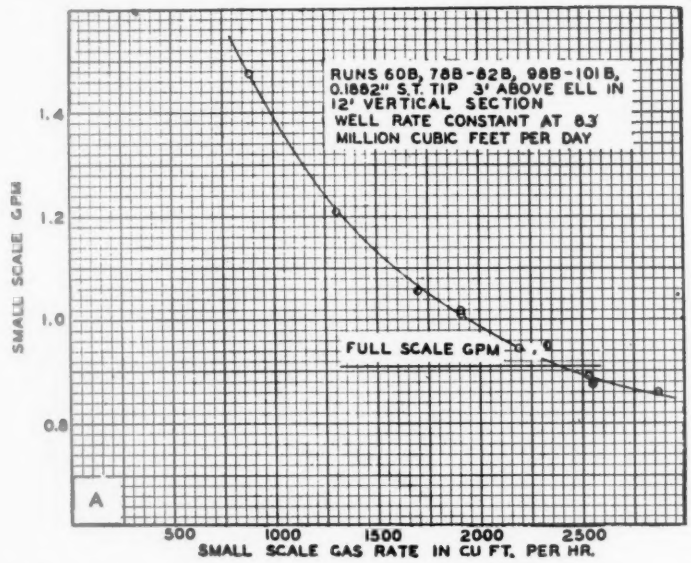


FIG. 3. Velocity distribution across flowing stream.

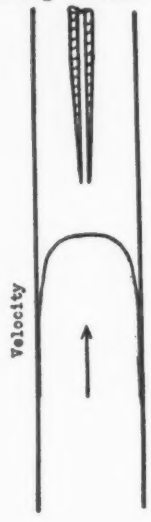


FIG. 4. Liquid distribution across flowing stream.

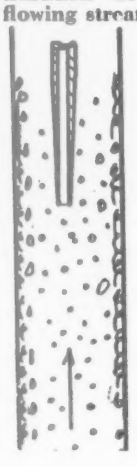
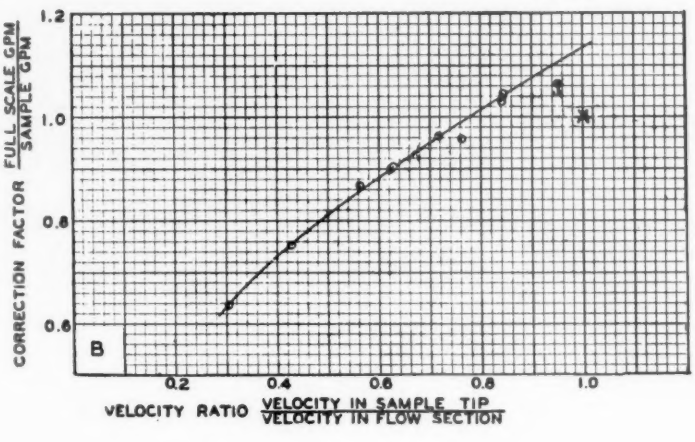


FIG. 5. Correction factor versus velocity ratio for data of Fig. 2.



is withdrawn through the sampling tip gives a lower liquid content in the sample.

● **Nature of two-phase streams.** The flow of the stream through the pipe is at such a high velocity in all of these operations that the flow possesses those characteristics known as turbulent. This does not mean that the gas and liquid are all mixed up in a substantially uniform character but simply that the gas is not moving solely in the linear direction of the pipe but is also moving in eddies and in radial directions. The velocity distribution across the pipe is indicated in Fig. 3. The stream is indicated as flowing vertically with the maximum velocity in the center of the pipe and with a very low velocity approaching zero at the boundaries of the flowing stream on the inside surface of the pipe. The horizontal dashed line at about eight-tenths of the maximum velocity is the average velocity computed by dividing the total volume of material flowing through the pipe per unit of time by the cross-sectional area of the pipe. It is clear that the actual velocity at the center of the pipe is greater than this average velocity and that the velocity adjacent to the walls of the pipe is less than this average velocity.

With two phases flowing upward through the pipe it is known that the liquid is distributed very unevenly across the diameter of the pipe as indicated in Fig. 4. There is usually a "film" of liquid flowing along the wall of the pipe which varies in thickness and velocity depending upon the flow conditions. Some liquid is carried as droplets suspended in the gas stream and these move with velocities approximating that of the gas which is carrying them upwards or horizontally through the pipes. The exact distribution of liquid is not known, but these statements are qualitatively correct.

When the thin walled tip is inserted in the stream, as indicated in Fig. 4, the liquid droplets will tend to enter the tip with a velocity equal to the vertical component of the liquid droplets just downstream from the tip. The gas phase being the continuous phase, will enter the tip at a velocity dependent upon the pressure differential at the tip. This is in turn controlled by the throttling valve on the small scale sampler at the end of the tube connected with the tip. Therefore, if a sample of fluid is desired having the same proportions of gas to liquid as that part of the stream immediately downstream from the tip, the velocity with which the sample is drawn into the tip should be equal to the linear velocity of the full scale stream at the same position in the pipe. This assumes that the tip is composed of such a thin wall as to have negligible disturbance to the flow of the gas and liquid immediately downstream from the tip.

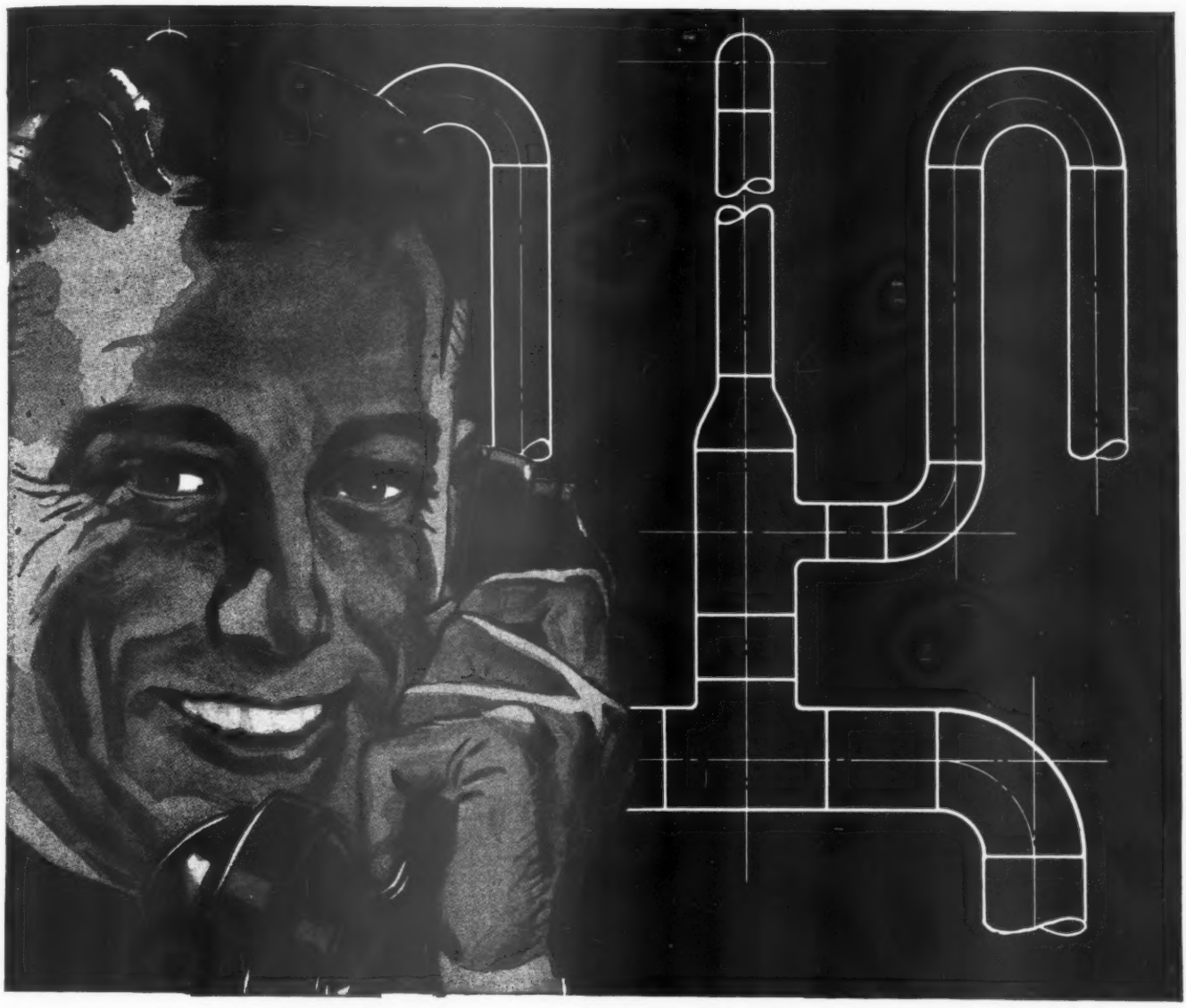
Since the linear velocity at the central part of the pipe is not known, and cannot be computed accurately, it is necessary to base all velocities on the overall flow rate of the entire stream through the pipes. This velocity computed by dividing the total flow of the stream by the cross-sectional area is known as the average velocity and is the only velocity of any practical significance.

Since it is desired that the sample contains a liquid content representative of the entire flowing stream rather than that of the stream flowing in the center part of the pipe only, it is necessary to withdraw into the sample tip a different proportion of liquid to gas than actually exists at that point in the flowing stream. The velocity with which the sample must be withdrawn into the tip

TABLE I—Summary of all useful data taken with line sampler A at Katy and Erath.

Run no.†	Flow rate, MM. cu. ft. per day	Pressure	Tip position	Gal. per M.	Velocity ratio for correct sample
			Horizontal position		
E191B	4.9	2200	2¾ in.	1	3.27
E202B	8.3	2300	2¾ in.	1	3.27
E685	8.5	1350	2¾ in.	1	2.04*
K79-81	6.3		6 in.	0.4	0.8
K74-78	7.3		6 in.	1	1.5*
K	8.0	2000	12 in.	0.4	0.72
K	8.0	1500	12 in.	0.4	0.63
K_1	8.0	1500	12 in.	1.4	0.72
			Vertical position		
E1271	8.0	2300	14 in.	1.0	0.64
E1276	8.0	2300	10⅛ in.	1.0	0.65
E1348	3.0	2220	10⅛ in.	1.0	0.76
E1351	3.0	2850	10⅛ in.	1.0	0.55*

*Extrapolated. †Prefix E means Erath data; prefix K means Katy data.



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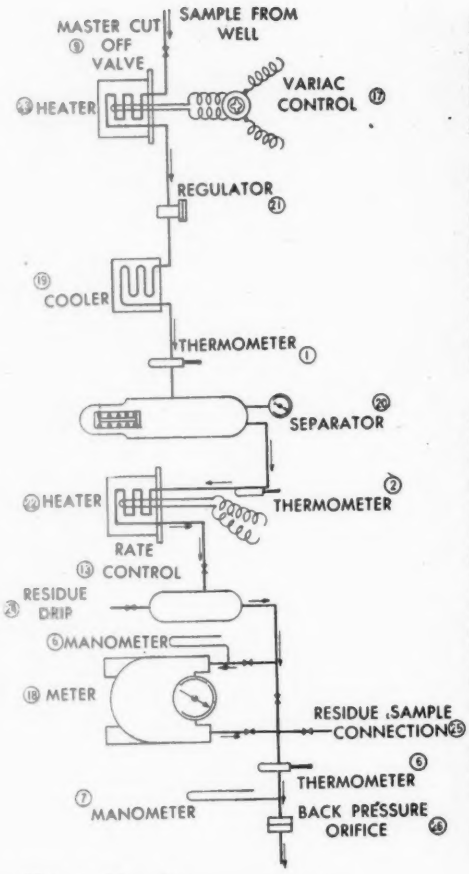

FIG. 6. Flow diagram—test Apparatus "A". Electrical circuit and cooling system, not shown.

in order that the sample contain the proportion of gas to liquid of the entire flowing stream, can be determined only by calibration against a full scale separator taking data as indicated in Fig. 2.

If the average linear velocity through the sampling tip required to accomplish this result happens to be the same as the average velocity of the entire stream through the flowing section, for obtaining the correct sample, this is purely fortuitous as it depends upon the liquid distribution, the velocity distribution, and how these factors are disturbed by the introduction of the tip in the stream.

The distribution of liquid in the flowing stream depends upon mechanical disturbances to the flowing stream if these disturbances are relatively close to the point of sampling. In order that the liquid distribution may reach a reproducible pattern in a straight vertical tube of constant cross-sectional area it is necessary that the sampling tip be placed a certain minimum distance down stream from the last interference. By the use of orifices, venturi tubes, and other interferences in the flowing stream such as a packed section, it is possible to produce in the flowing stream a reproducible liquid distribution at a distance down stream from the restriction which is much less than that required in a straight tube of constant diameter free from such constriction.

These devices employing orifices, venturi tubes or packed sections are frequently referred to as "line samplers". They are usually very sensitive to tip position, but may give a reproducible distribution of liquid over the cross-sectional area over wider ranges of flowing conditions than is the case with the plain, straight tube.

● **Calibration of sampling devices.** In the calibration of any sampling device it is customary to run the small scale separator and the full scale separator under the same conditions of temperature and pressure in obtaining data as reported in Fig. 2. By dividing the "liquid content (gal. per M.)" as determined in the full scale separator by the "liquid content" of the sample stream as determined in the small scale separator operating under the same conditions of temperature and pressure, a dimensionless factor is obtained which is called the *correction factor*. The sample is truly representative of the entire stream flowing through the line when the correction factor is unity (1.00). If the correction factor is other than unity the sample is not representative of the entire flowing stream and there is no way of making the sample representative of the flowing stream. A correction factor greater than unity indicates a lean sample and a correction factor less than unity indicates a rich sample as compared with the full scale stream. The object of all sampling procedure is to obtain a correct sample with correction factor of unity (1.00).

This "liquid content (gal. per M.)" is the actual liquid present under the conditions existing in the separator and is not the total recoverable liquid hydro-

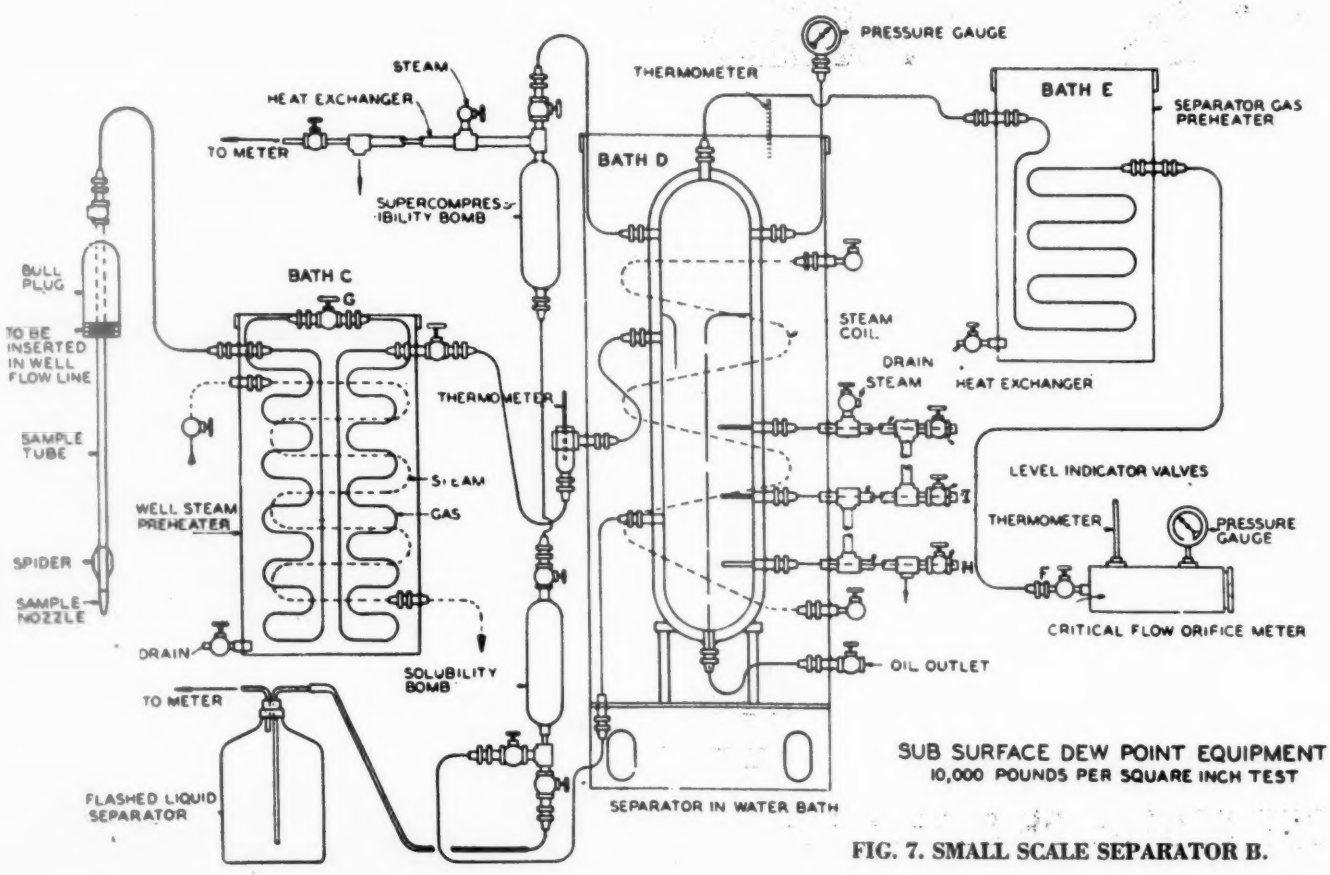

FIG. 7. SMALL SCALE SEPARATOR B.

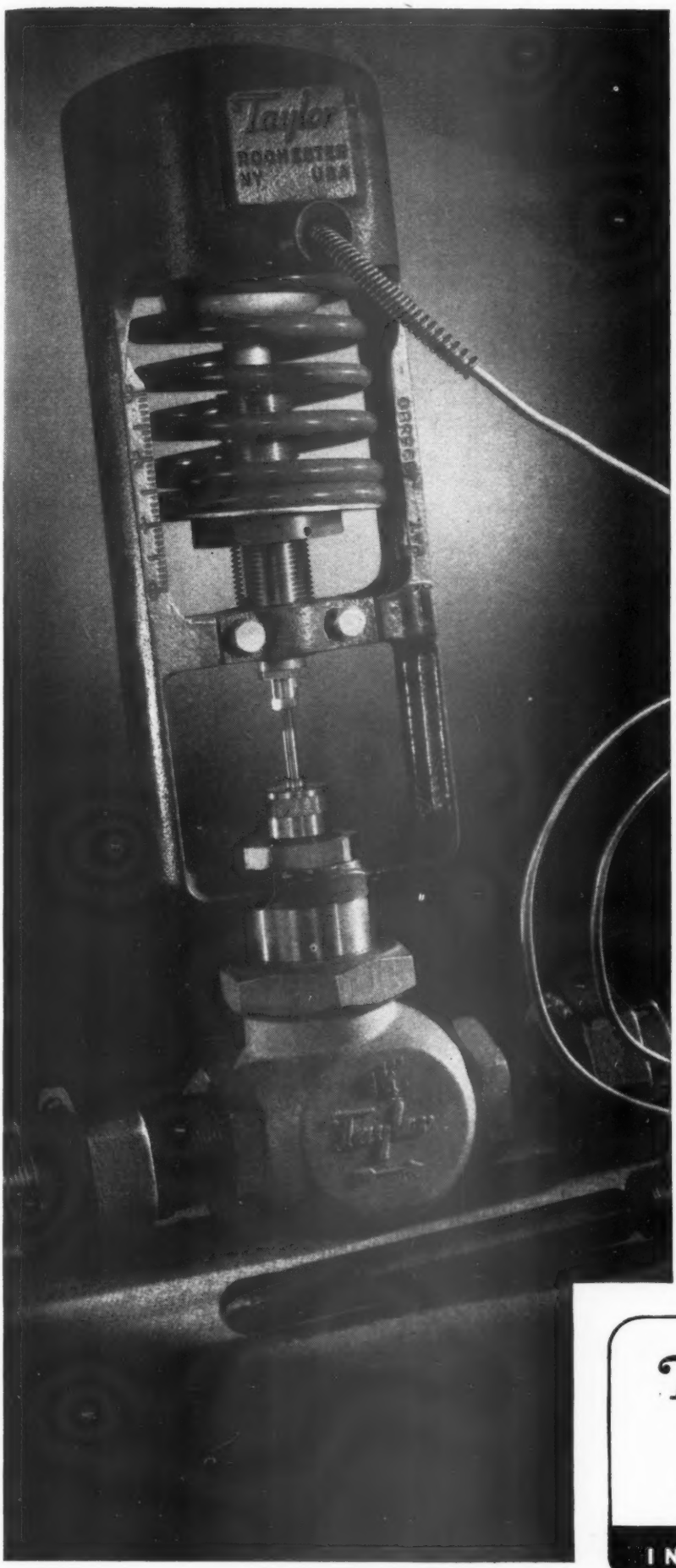

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FIG. 8. Comparison of data with Separators A and B.

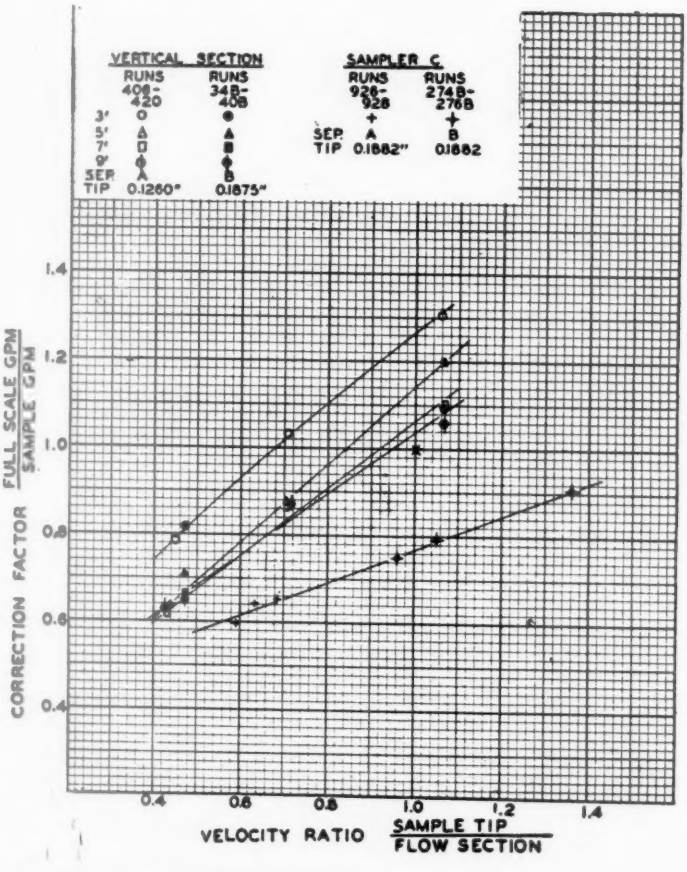


FIG. 11. Comparison of blunt and S.T. tip in vertical section.

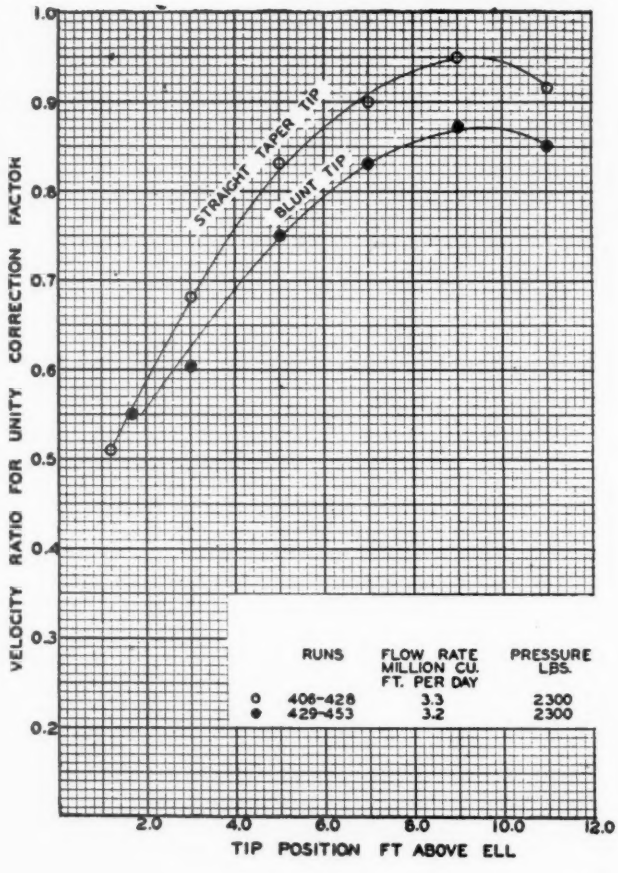
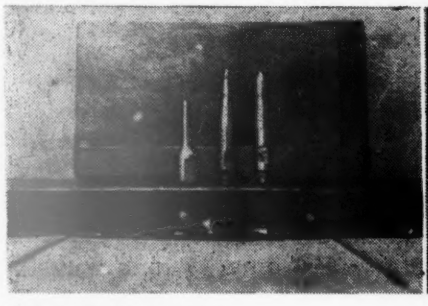


FIG. 9. Sample tips and Sampler B.



Sharp, straight taper, blunt sampling tips.

Spiders and sampling tips including small tips for sampler B.

Sampler B dismantled.

Sampler B connected for sampling.

carbons usually referred to as liquid content or gal. per M. The liquid content used in this report is much less than the liquid content of recoverable hydrocarbons, and is used simply as a means of calibrating the sampling procedure.

The best practical method of defining the velocity of sampling is in terms of "the velocity ratio" which is determined by dividing the average velocity in the sample tip by the average velocity in the flow section. The average velocity in the flow section is determined from the area of the pipe or flow section and the total stream flowing.

If the data of Fig. 2 are plotted in terms of the correction factor and the velocity ratio as defined, the curve shown in Fig. 5 is obtained. In this case the correct sample (correction factor equals 1.00) was obtained with a velocity ratio of 0.78, that is the velocity in the sample tip was 78 per cent of the average velocity in the pipe section. The asterisk shows the point of unit correction factor and unit velocity ratio which is placed on the figure solely as a point of reference.

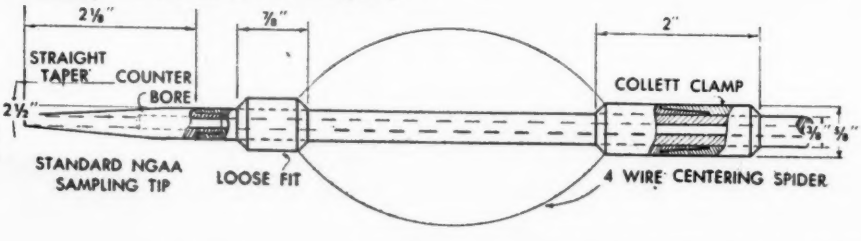


FIG. 10 (Right) Sampling tip and centering spider.

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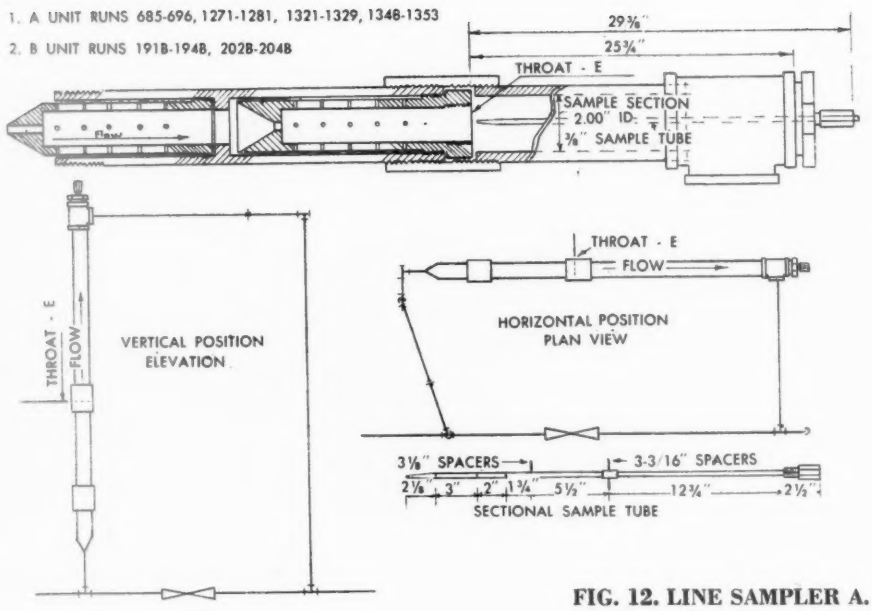

FIG. 12. LINE SAMPLER A.

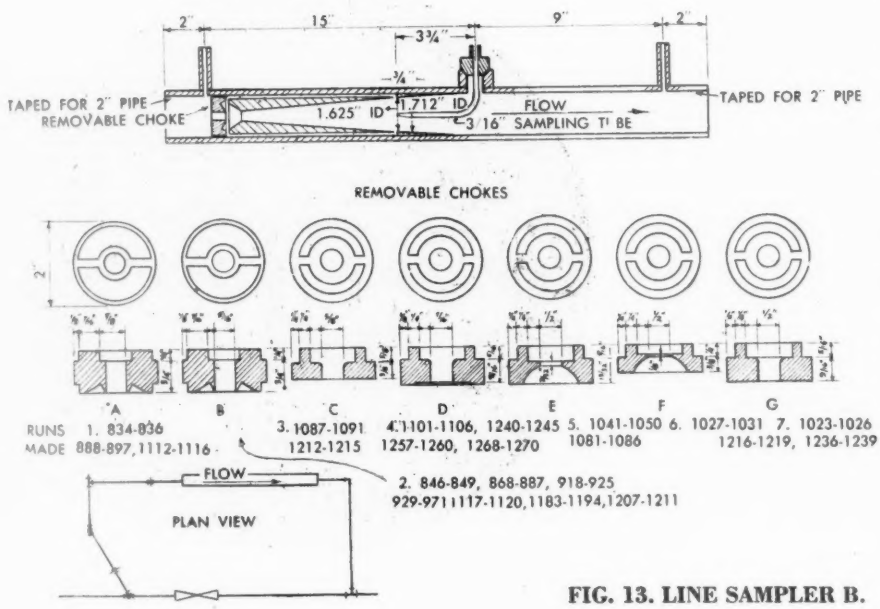

FIG. 13. LINE SAMPLER B.

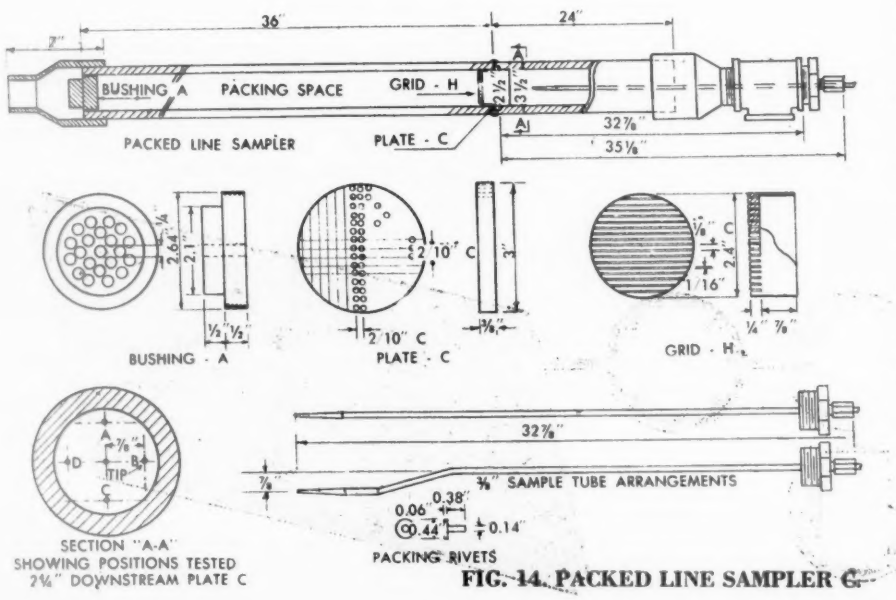

FIG. 14. PACKED LINE SAMPLER C.

The ideal sampling device would be insensitive to the velocity ratio and would have the characteristics of a horizontal line at unit correction factor on Fig. 5. It is clear that this is a limiting case which may be approached but can never be attained except in the case of a wholly homogeneous stream such as a dry gas. From practical considerations the most desirable sampling device would be one that would give the identical curve for all data plotted on Fig. 5 independent of flow rate, liquid content, pressure and temperature.

Of these variables the only information to the tester when testing an unknown well is the flow rate, pressure and temperature of the well stream. It is therefore particularly desirable that the sampling procedure gives the correct result independent of the liquid content as this is the one variable unknown to the tester.

● **Research on sampling procedures.** Previous work on the sampling procedure include two short series of tests by the Technical Committee and High Pressure Gas Division of the NGAA[1, 2] in 1941 and 1942. Parks and Flaitz[3] reported the results of their tests to the AIME. Bennett, Williams, and Kimmell[4] described a small scale sampling apparatus and tests on a condensate well. Eilerts and coworkers[10] calibrated sampling procedure by full scale tests on each well. In the summer of 1943, a research project was conducted by the NGAA at the Katy field[5, 6, 7]. These projects emphasized the complicated nature of the problem and the need for a quantitative study of the variables involved. In the fall of 1944 and spring of 1945 the sampling research project of the NGAA was continued at Erath, Louisiana[8]. This report is based primarily on the results obtained at Katy and Erath with some independent test data on sampling from tubings of wells[9]. The tests at Katy to determine the proper procedures for obtaining a true small scale sample from a two phase gas-condensate stream, included pipe diameter, liquid content, flow rate, pressure, tip

[1] "The Testing of High Pressure Gases," C. H. Gee *NGAA Proceedings*, p. 25 (1942) (Wardner No. 9).

[2] "The Testing of High ressure Gases," W. L. Bowser, *NGAA Proceedings*, p. 6 (1943) (Lockhart Luling Foundation).

[3] "Sampling Gas Condensate Wells," J. M. Flaitz and A. S. Parks, *AIME Transactions*, Vol. 146, p. 13 (1942).

[4] "Experiments on Sampling and Behavior of Natural Gas Condensate Mixtures," E. O. Bennett, C. R. Williams and G. O. Kimmell, *The Petroleum Engineer*, Vol. 13; No. 10, p. 99 (1942).

[5] "The Sampling and Metering of Wet Gas from High Pressure Condensate Wells," G. G. Brown and D. L. Katz, *NGAA Proceedings*, p. 46, 1944 (Katz).

[6] "Field Study of High Pressure Gas Sampling," C. C. Pryor, *The Petroleum Engineer*, September, 1943, p. 51.

[7] G. G. Brown and D. L. Katz, (a) Report to NGAA on metering and sampling experiments at Katy, May 29, 1944. (b) Progress Report, October 13, 1943.

[8] D. L. Katz, A. S. Parks, and G. G. Brown, report to NGAA on sampling research at Erath, September, 1945.

[9] G. O. Kimmell, private communication, 1943.

[10] "Measuring Distribution of Liquids in Flowstring of a Gas Condensate Well," Eilerts, Smith and Barr, *O. & G. J.*, Vol. 44, No. 32, p. 91 (1945).

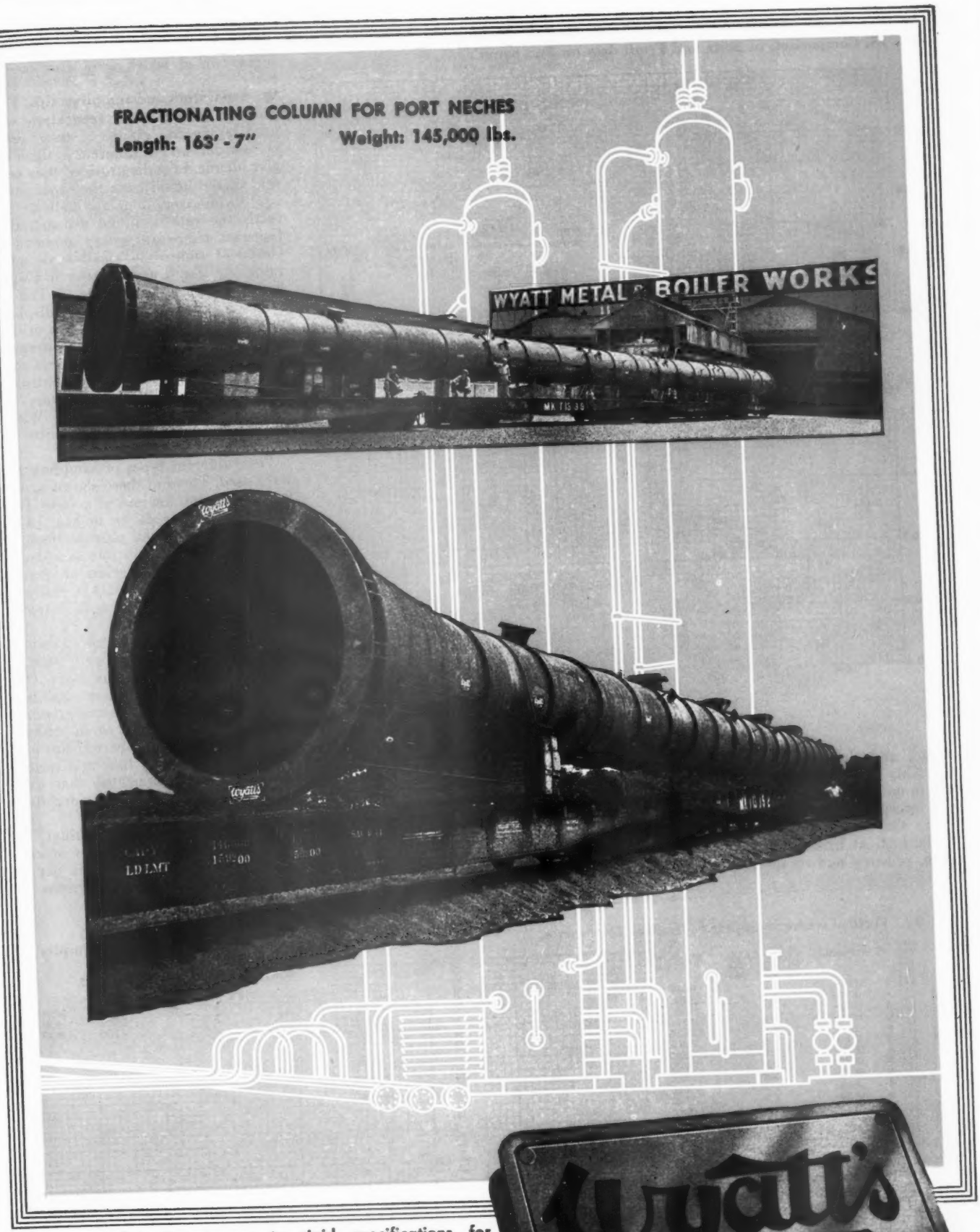

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FIG. 15. Comparison of Katy and Erath data on line Sampler B.

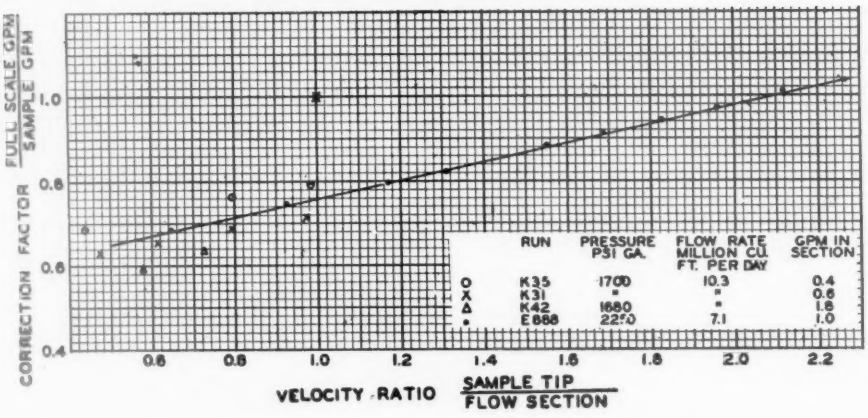
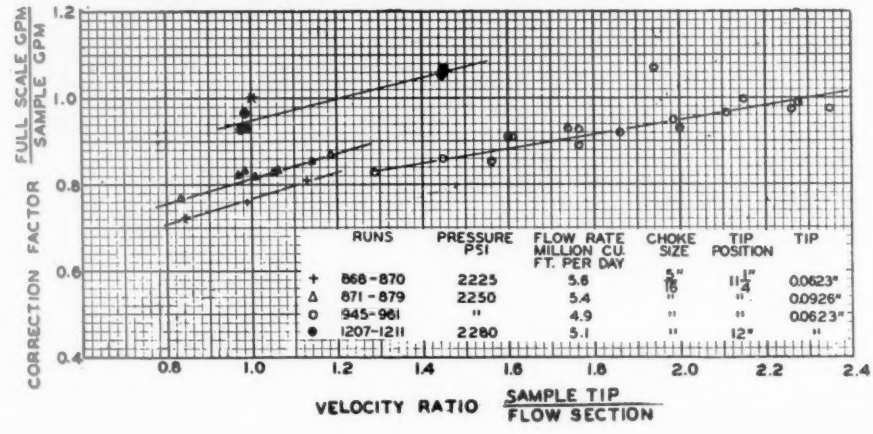

FULL SCALE GPM / SAMPLE GPM
CORRECTION FACTOR
VELOCITY RATIO SAMPLE TIP / FLOW SECTION
RUN PRESSURE PSI GA. FLOW RATE MILLION CU. FT. PER DAY GPM IN SECTION
O K35 1700 10.3 0.4
X K31 " " 0.6
Δ K42 1680 " 1.8
• E888 2270 7.1 1.0

FIG. 16. Effect of tip position in Sampler B—Horizontal.


FULL SCALE GPM / SAMPLE GPM
CORRECTION FACTOR
VELOCITY RATIO SAMPLE TIP / FLOW SECTION
RUNS PRESSURE PSI FLOW RATE MILLION CU. FT. PER DAY CHOKE SIZE TIP POSITION TIP
+ 868-870 2225 5.6 5/16" 11 1/4" 0.0623"
Δ 871-879 2250 5.4 " " 0.0926"
O 945-961 " 4.9 " " 0.0623"
• 1207-1211 2280 5.1 " 12" "

design, and tip position as variables. The Katy tests were primarily exploratory in nature as accumulation of distillate forced discontinuance of the tests before the indicated conclusions could be checked. At Erath, flow rate, tip position, pressure and tip design were the independent variables. The tests were designed primarily to calibrate the two inch pipe sampling section in vertical and in horizontal positions under conditions indicated to be satisfactory from the earlier tests at Katy, but also included tests on three different line samplers, two of which were also used at Katy.

● **Separators and sampling tips.** Four different small scale separators were used in the two groups of tests. Small scale separators of different designs will give identical results provided they separate all the liquid from the vapor under equilibrium conditions and indicate correctly the rate of liquid accumulation. Constant temperature was obtained by electrical control in small scale separator "A," Fig. 6, and by steam in a water bath for separator "B", Fig. 7. The gas rate was measured by a positive displacement meter in one case and by a critical flow orifice in another. Back pressure was held constant by a regulator in some cases and by manual valve control in others. The results from separators "A" and "B" are compared in Fig. 8[8]. Within the experimental error the results are identical.

Four different types of sampling tips were used. Three of these shown in Fig. 9 were used on the end of a 3/8-in. O.D. sampling tube as shown in Fig. 10 for sampling in straight pipe sections, in line sampler A and in line sampler C. The fourth type of tips was of straight taper design of a 3/16 in. O.D. and were used with line sampler B as indicated in Fig. 13.

There are only a few direct comparisons between the "sharp" and "straight taper" tips as used on the 3/8-in. O.D. sampling tube. A limited number of tests at 0.7 to 1.0 gal. per M. and at pressures from 2200 to 2900 lb. per sq. in. with the "sharp" and "straight tapered" tips used on the 3/8-in. sampling tube in a vertical sampling section, indicated that these tips gave identical results under these sampling conditions.

Comparisons between the "blunt" tip and the "straight tapered" tip at various tip positions at about 1 gal. per M. are shown on Fig. 11. Comparisons be-

FIG. 17. Vertical packer Sampler C, tip 8 in. from plate.

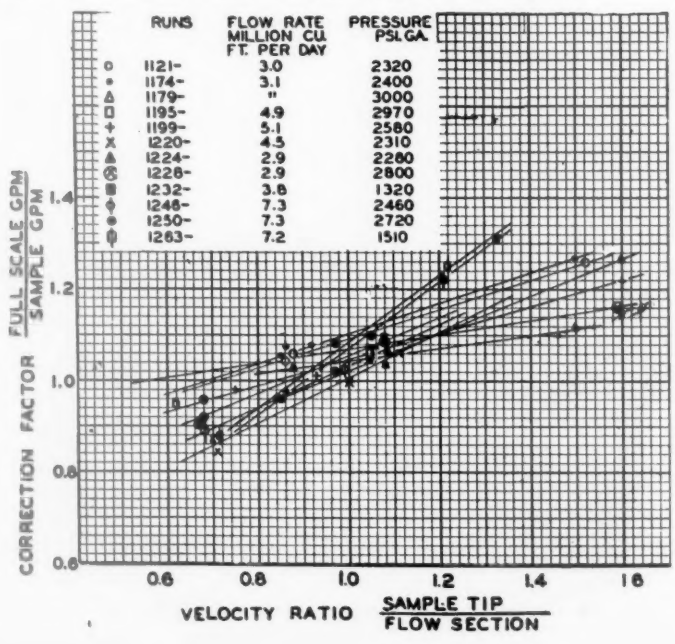
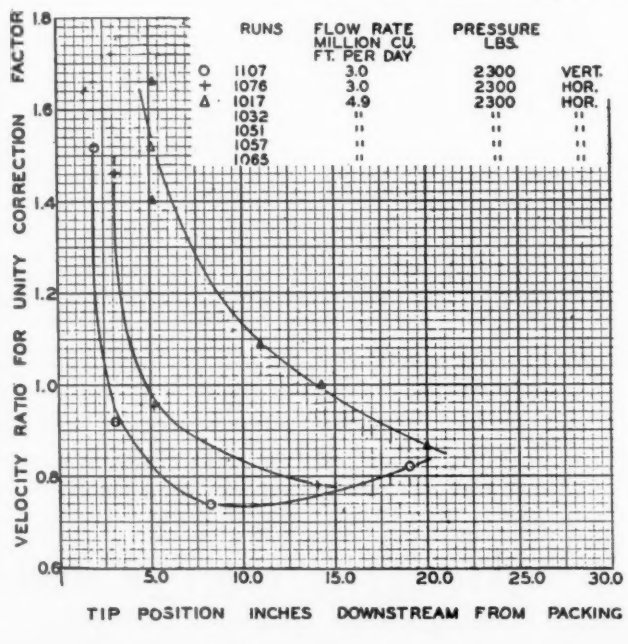


FIG. 18. Packed Sampler C.


VELOCITY RATIO FOR UNITY CORRECTION FACTOR
TIP POSITION INCHES DOWNSTREAM FROM PACKING
RUNS FLOW RATE MILLION CU. FT. PER DAY PRESSURE LBS.
O 1107 3.0 2300 VERT.
+ 1076 3.0 2300 HOR.
Δ 1017 4.9 2300 HOR.
1032 " " "
1051 " " "
1057 " " "
1065 " " "

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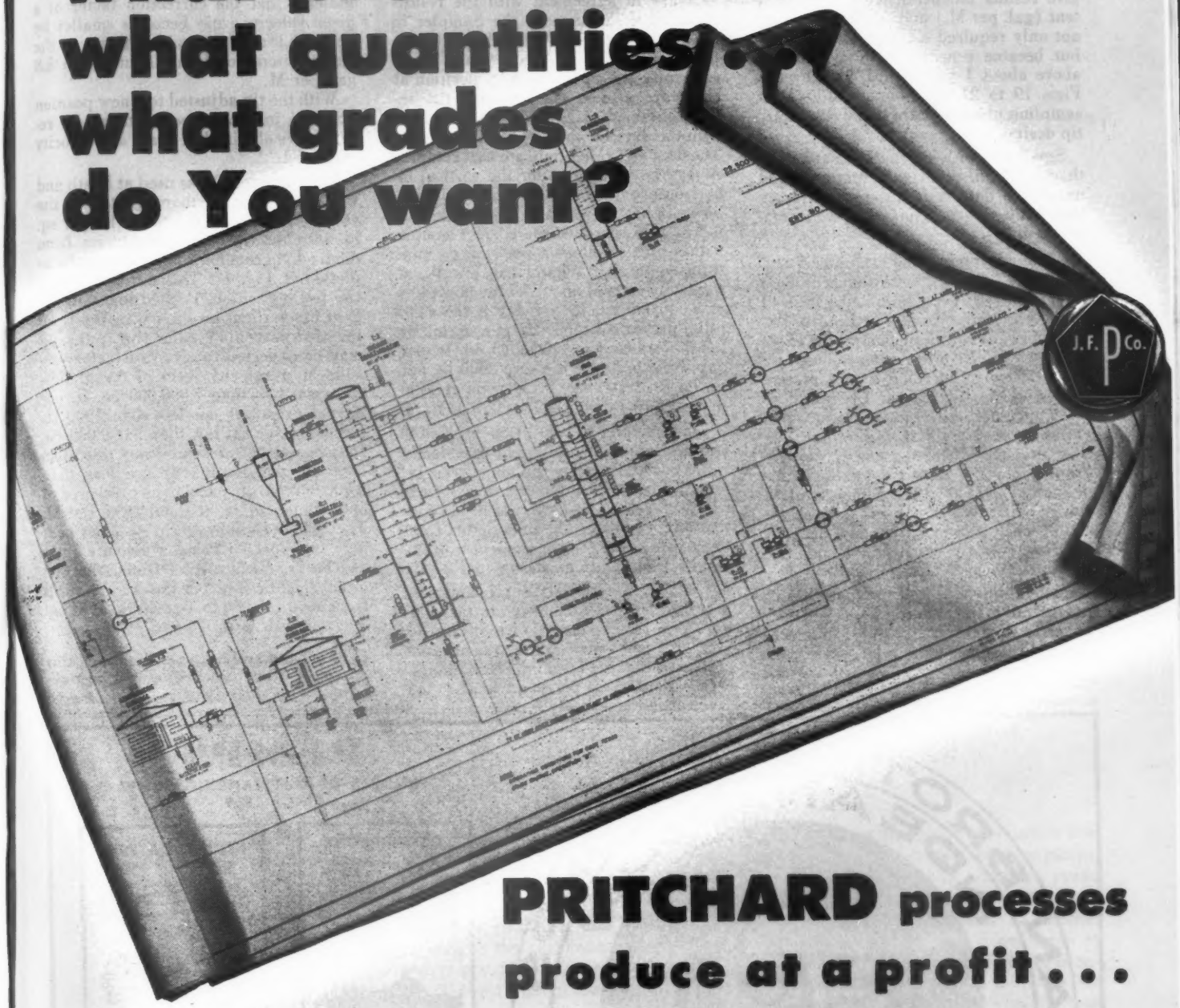

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tween sharp and blunt tips at Katy showed that the sharp tip appeared to give results independent of liquid content (gal. per M.) and that the blunt tip not only required a lower velocity ratio but became sensitive to liquid content above about 1 gal. per M. as shown in Figs. 19 to 21.* Recommendations for sampling procedure are based on a sharp tip design.

Small tips with internal diameters less than 0.125 in. often gave scattered and unreliable data. For this reason larger tips, not less than ⅛ in. O.D., are recommended.

● **Line samplers.** Line samplers A and B, Figs. 12 and 13, were tested at both Katy or Erath over a limited range of conditions while Sampler C, Fig. 14, was tested only at Erath. In general the effect of a line sampler is to permit the use of a short device rather than a pipe section of 60 diameters in length. The line samplers appear to be sensitive to the same variables as straight pipe sampling section and introduce a greater pressure drop. From the tests conducted it appears that any one of these line samplers can be calibrated to give reliable results under specified conditions. The data on each sampler are summarized with the appropriate conclusions.

Line sampler A was used at Erath[8] and at Katy[7b] with the results as given in Table I. Comparison of the last seven lines indicates that the results obtained at Katy with Sampler A in the horizontal position with the tip at the 12-in. position are in agreement with the results obtained at Erath with the Sampler in the vertical position and with similar tip positions of 10⅝ in. and 14 in. The results with the tip at the 6-in. position at Katy are also consistent with the results obtained at Erath when compared with the data for the 2¾-in. tip position. The data of Table I indicate that sampler A may be used in either the vertical or horizontal position with the tips 12 inches downstream from the orifice (plus or minus 1 in.) to give the correct sample within plus or minus 4 per cent on mixtures containing about 1 gal. per M., at a velocity ratio of about 0.7 for flow rates of 8,000,000 cu. ft. per day if the sampling pressure is 1500 lb. per sq. in., or for flow rates over 3,000,000 cu. ft. per day if the pressure is above 2000 lb. per sq. in. No tests have been made at 1500 lb. and flow rates of 3,000,000 cu. ft.

Line sampler B was used at Erath[8] and at Katy[7b] but the range of velocity ratios covered at Katy did not exceed 1.0 and the correction factors varied from 0.6 to 0.8 depending upon the liquid content of the sample. The data points from Katy (K) are in good agreement with the results from Erath as shown in Fig. 15.

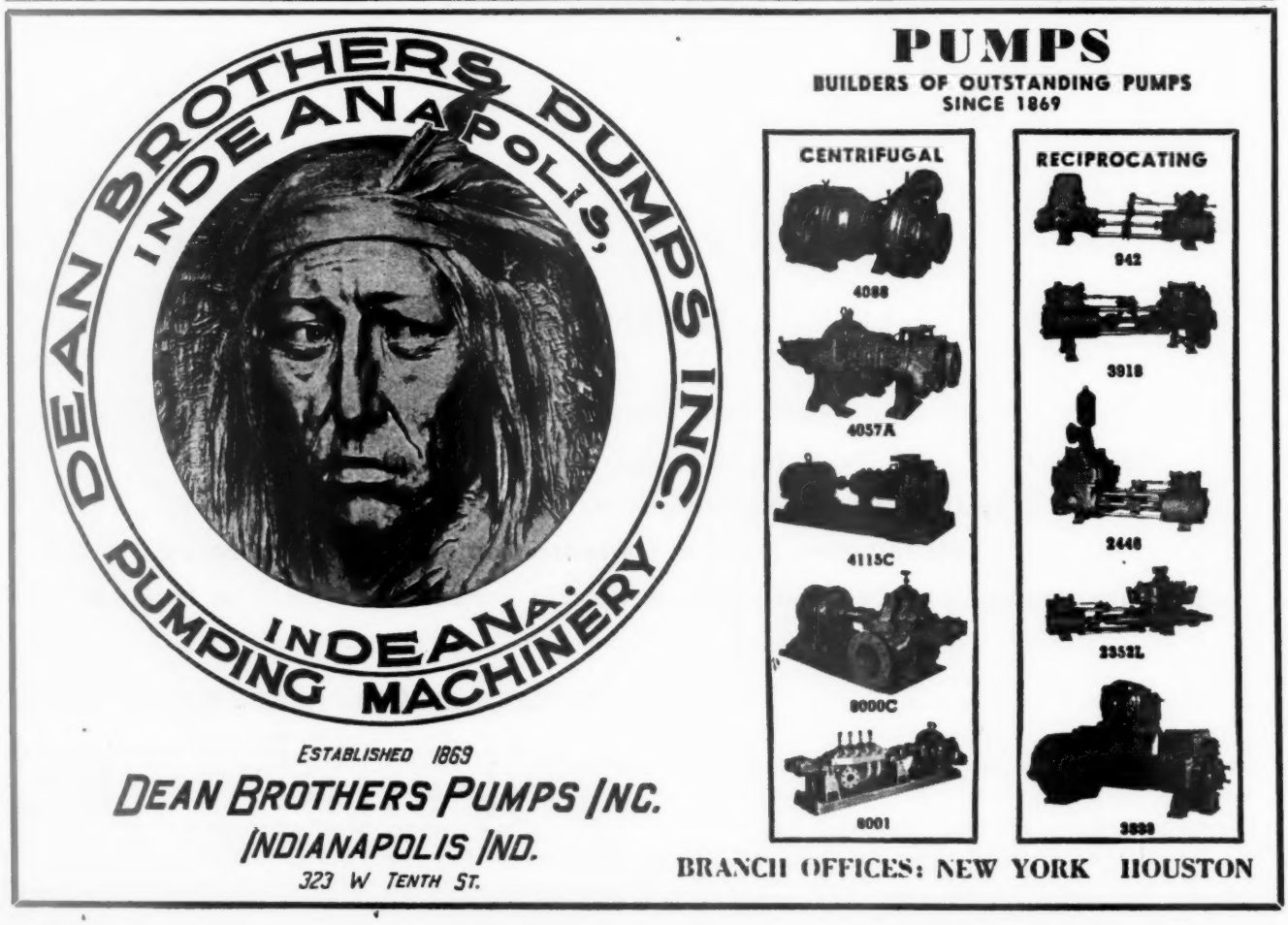
The Erath report[8] clearly indicates the sensitivity of this device to tip position, Fig. 16. The data shown on Fig. 15 were obtained with the tip in the original position and there is no information indicating that the tip position was changed between the tests at Katy and at Erath. The curves representing the Katy tests indicate that the correction factor at a given velocity ratio becomes smaller by about 0.1 as the liquid content of the stream increases from about 0.4 to 1.8 gal. per M.

With the tip adjusted to a new position about ¾ in. downstream satisfactory results were obtained at Erath at a velocity ratio of 1.22.

Line sampler C was used at Erath and was given a rather thorough test in the vertical position at 0.7 to 1.0 lb. per sq. in. with the tip 8 in. downstream from the packing retainer plate with results as plotted in Fig. 17. This device is sensitive to tip position. Packed line sampler C in the vertical position with the tip 8 in. downstream from the packing may be expected to give satisfactory results at a velocity ratio of 0.9 at flow rates not less than 7,000,000 cu. ft. per day at pressures not less than 1500 lb. per sq. in., or not less than 5,000,000 cu. ft. per day at pressures not less than 2300 lb. per sq. in., or not less than 3,000,000 cu. ft. per day at pressures of 3000 lb. per sq. in. at about 1 gal. per M. The correct sample within ± 7 per cent may be expected using a velocity ratio of 0.85 for all flow rates from 3,000,000 to 8,000,000 cu. ft. per day at pressures from 1300 to 3000 lb. per sq. in. at about 1 gal. per M. (Fig. 18.)

*These will be in Part 2.

(The second and last installment of this article by Katz and Brown will be published in an early issue.) ★★★



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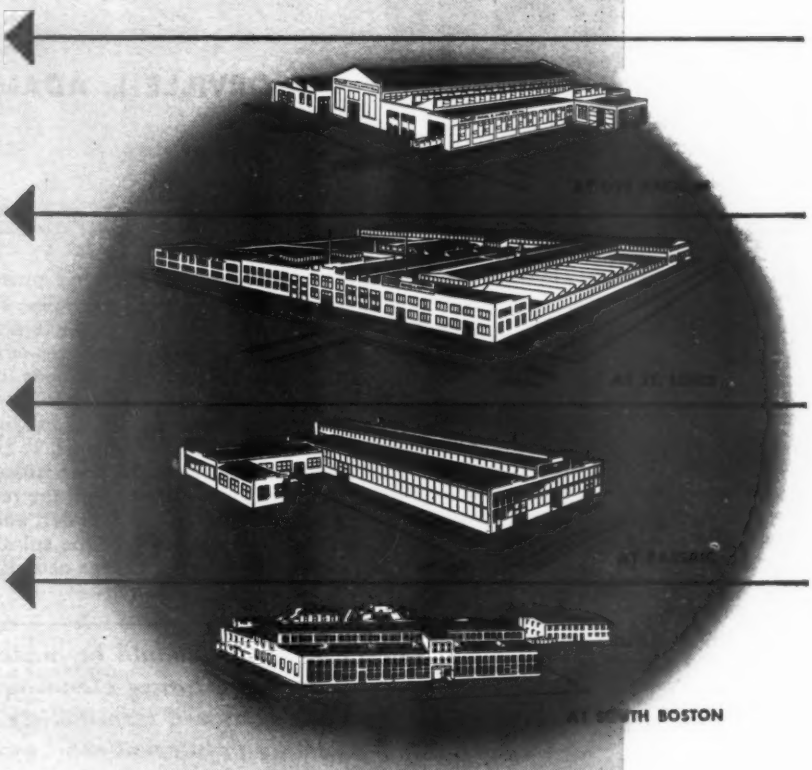

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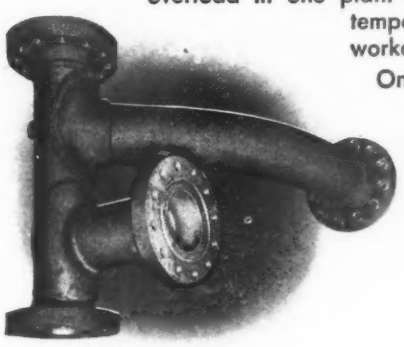

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PIPING FABRICATORS AND CONTRACTORS

Volumetric efficiency of the diesel

By ORVILLE L. ADAMS

THE conventional definition for volumetric efficiency of the internal combustion engine fails when applied to the diesel engine, mainly because the diesel is always incompletely scavenged. Dr. P. H. Schweitzer, professor of engineering research, Pennsylvania State College, in an attempt to clear up some of the confused terminology relating to internal combustions has shown how the conventional definition breaks down owing to the excess air always required and the mixing of some of this air with the residual gases. He has shown that any satisfactory definition must consider the charge in the cylinder and not the air in the charge. A definition satisfactory and usable for practical engine work would apply to the two-stroke cycle and the supercharged four-cycle engine as well as to the normally aspirated four-stroke cycle.

EXCLUSIVE

In order to be consistently satisfactory, the definition would show that the cylinder output increases rather than decreases when the scavenging is improved by lowering the relative amount of residual gases. The conventional definition usually applied to the four-stroke cycle, normally aspirated engine does not show this to be true. In this type of engine, the air retained (V_{ret}) is usually assumed to be equal to the air delivered when there is no valve overlap. Then, the air consumption per cycle (NTP) is divided by the displacement volume to obtain the volumetric efficiency. The simplicity of this process disappears, however, when the definition is applied to the two-stroke cycle or to a four-stroke supercharged engine having a considerable overlap of the valve timing. The usual definition does not take into account the condition of the air charge for engines using excess air and being incompletely scavenged, and works only when the air-fuel ratio is reasonably close to the chemically correct ratio and the scavenging is almost complete.

Engine output is determined by the fresh air charge used in the engine. The volumetric efficiency is a measure of this fresh air charge, and it is influenced by the air left in the residual gases. Consequently, the power output increases both with the volumetric efficiency and the amount of air in the residual gases. If the volumetric efficiency is to indicate the success attained in filling the cylinder irrespective of the composition of the charge, the scavenging pressure, valve overlap, and residual gases must be be considered.

Analysis of the charging process of an internal combustion engine can be better understood by inspection of the diagram, Fig. 1. It shows that not all the air contained in the cylinder charge burns during the combustion process, but that some of the air mixes with and escapes through the exhaust. It also indicates that an appreciable amount of the excess air is mixed with the residual gases, remains in the cylinder, and participates in the work of the subsequent cycle. The cylinder charge actually consists of a working substance comprised of three parts: (1) The retained portion of the air delivered, (2) part of the residual combustion products from the preceding cycle, and (3) part of the excess air from the preceding cycle mixed with the residual combustion products. The air delivered to the cylinder is evidently first split into two parts: (1) The air short circuited, which escapes through the port or valve overlap, and (2) the air retained and trapped in the cylinder when the valve, or port, closes. The air delivered is thus:

$$V_{del} = V_{short} + V_{Ret.} \quad . \quad . \quad . \quad . \quad (1)$$

All V's signify volumes NTP. The utilization factor, η_{ut} (see definitions), is an index of the amount of air retained. Therefore, η_{ut} is the relative amount of air short circuited to the exhaust and cannot participate in the combustion. The utilization factor is the measure of the success of the engine in utilizing air without too much waste. The effectiveness of the scavenging system largely determines this factor. Increasing the amount of delivered air generally increases the amount of air retained, with the ratio being

$$L = \frac{V_{del}}{V_{disp}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This ratio is a measure of the air fed into the cylinder, and when engines are pressure charged, the ratio is influenced by the capacity of the blower. The cylinder charge V_{ch} is then equal to the air retained, V_{ret} plus the residual gas V_{res} remaining in the cylinder after the scavenging is completed. How this charge may be more, or may be less, is shown to depend on the volumetric efficiency when stated as follows:

$$\eta_{vol} = \frac{V_{ch}}{V_{disp}} = \frac{V_{ret} + V_{res}}{V_{disp}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This expression considers that only a part of the air contained in the charge burns during combustion, and the part that does not burn is accounted for. This requires consideration of the scavenging efficiency, which measures the engine's effectiveness in clearing the residual gases of the preceding cycle from the cylinder. This is expressed by

$$\eta_{sc} = \frac{V_{ret}}{V_{ch}} = \frac{V_{ret}}{V_{ret} + V_{res}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This will give a true indication of the contamination of the air charge by the residual gases of the preceding cycle. It can be determined by gas analysis also. Charging efficiency simply refers to the amount of fresh air available for combustion, not necessarily what is used by the combustion process. This term should not be used for or confused with volumetric efficiency even though it is roughly proportional to the volumetric efficiency of the four-stroke cycle engine.

Algebraically, it can be shown that

$$\eta_{ch} = \eta_{sc} \times \eta_{vol} = \eta_{ut} \times L \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

This gives us a terminology that is convenient and that can be consistently applied to both the two-stroke cycle and the four-stroke cycle engine. If $V_{res} = 0$, $\eta_{sc} = 1$, and $\eta_{ch} = \eta_{vol}$, the conventional definition would then be simplified to

$$\eta_{vol} = \frac{V_{ret}}{V_{disp}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

This would be valid enough. With the foregoing terminology established, however, a new volumetric efficiency definition can be written.

Efforts should be made to do some house cleaning in the confused terminology relating to internal combustion engines. So thinks the author, who here presents a study of two papers, both by Dr. P. H. Schweitzer, Professor of Engineering Research, Pennsylvania State College, read before the Oil and Gas Power Division, ASME.

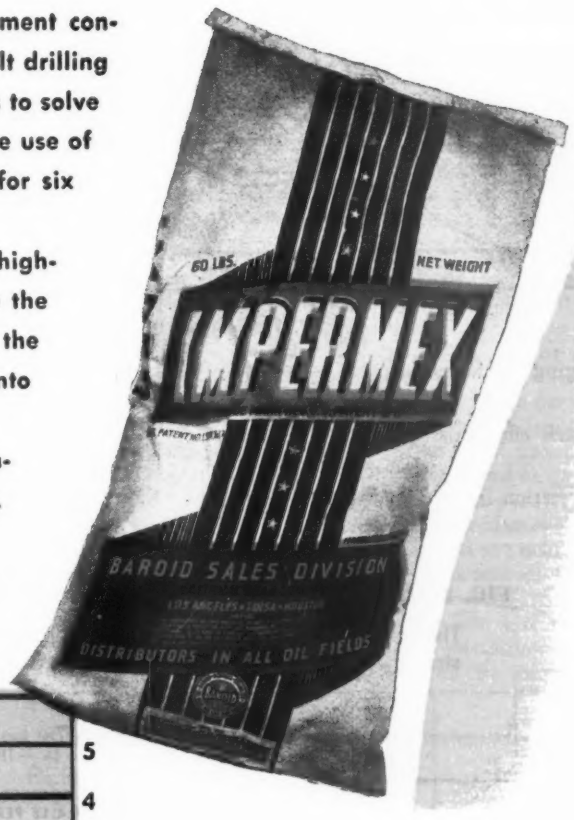
IMPERMEX PROVIDES FASTER, MORE ECONOMICAL AND BETTER COMPLETIONS IN HACKBERRY FIELD, LOUISIANA

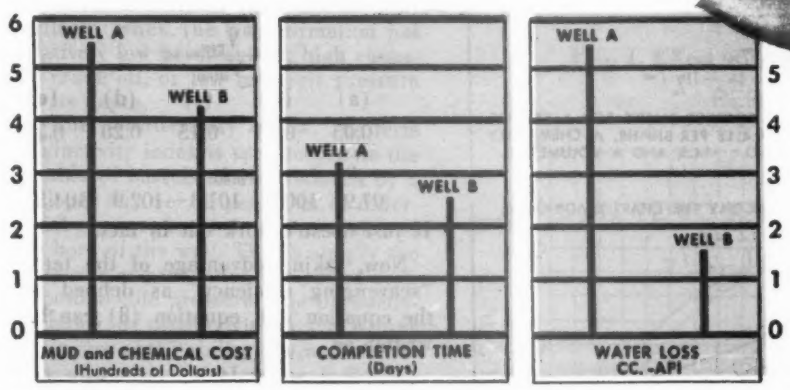
Salt contamination from upper shale formations and cement contamination from squeeze jobs have presented two difficult drilling mud problems in the Hackberry field, Louisiana. Attempts to solve them with the use of ordinary clay colloids resulted in the use of excessive amounts of clay and chemicals and the need for six to ten hours of rig time to condition the mud.

One operator solved both problems by converting to a high-pH, lime- IMPERMEX mud several hundred feet above the producing sand. RESULT: He lowered the total mud cost, the rig time, and the water loss of the mud used to drill into the pay zone.

Any one of these factors—cost, time saved, mud improvement—would have justified the use of IMPERMEX. But IMPERMEX scored on all three counts!

The chart below shows graphically the superior results obtained by using IMPERMEX in the Hackberry field.





Well "A" was drilled using the conventional chemically treated clay mud. Well "B", using the same rig and crew, and drilling to the same depth, converted to an IMPERMEX mud before reaching the pay zone.

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$$\eta_{vol}\frac{V_{ret}+V_{res}}{V_{disp}}=\xi_{vol}+\frac{V_{res}}{V_{disp}} \quad \ldots\ldots\ldots\ldots (7)$$

Remembering that the residual gas may contain a considerable amount of air from the preceding cycle, and that this air participates in the combustion of the subsequent cycle, thus influencing the output of the engine, the following relation must exist between the volumetric efficiency and the bmep of the engine:

$$b_{mep}=180\frac{0.4}{f}\frac{14.5}{r_{th}}\frac{1}{\frac{1}{\xi_{vol}}+\frac{\lambda-1}{\xi_{vol}+\frac{V_{res}}{V_{disp}}}} \quad \ldots\ldots\ldots\ldots (8)$$

where f is the specific fuel consumption, lb per bhp-hr, r_{th} is the theoretically correct air-fuel ratio by weight, ξ_{vol} is the conventional volumetric efficiency, or V_{ret}/V_{disp}, r is the actual air-fuel ratio by weight and λ is the excess air factor $= r/r_{th}$, and V_{ret} is the amount of residual gas in the cylinder charge, cu ft NTP, and V_{ret} is the amount of fresh air retained in the cylinder, cu in. If the residual gas $V_{res} = 0$, equation (8) would simplify to

$$b_{mep}=180\frac{0.4}{f}\frac{14{,}5}{r_{th}}\frac{\xi_{vol}}{\lambda} \quad \ldots\ldots\ldots\ldots (9)$$

which is the familiar relation between mep, volumetric efficiency, and the excess air factor defined better by Fig. 2. When the normal fuel consumption is 0.4 lb per bhp-hr and $r_{th} = 14.5$, the highest bmep for the normally aspirated engine is 180 psi, taking both the volumetric efficiency and the excess air factor as 1.0. In the normal diesel engine V_{res} is not zero, and the bmep will depend upon the amount of V_{res}.

If equation (8) is used, it will be seen that when V_{res} increases the b_{mep} also increases. This would mean that the poorer the scavenging, the higher the b_{mep} and the engine output, but this cannot be true.

It is contrary to fact. For illustration, assume 50 per cent excess air, $\lambda = 1.5$, $\xi_{vol} = 0.8$, f = 0.4 lb per bhp-hr, and $r_{th} = 14.5/1$, which are all average values. Then with:

$\frac{V_{res}}{V_{disp}} =$

(a)	(b)	(c)	(d)	(e)
0.05	0.10	0.15	0.20	0.25

$b_{mep} =$

97.9	100.8	101.3	102.9	104.3

It just doesn't work out in fact.

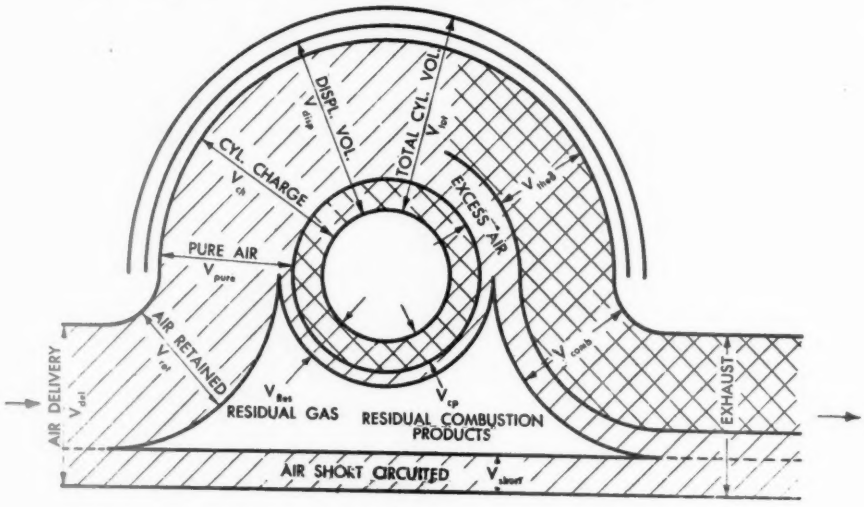
Now, taking advantage of the term "scavenging efficiency" as defined in the equation (4), equation (8) can be written as

$$B_{mep}=180\frac{0.4}{f}\frac{14.5}{r_{th}}\frac{\eta_{sc}}{1+(\lambda-1)\,\eta_{sc}}\eta_{vol} \quad \ldots\ldots\ldots\ldots (10)$$

This forces us to draw the conclusion that the conventional definition of volumetric efficiency is unsatisfactory for diesel work. ★★★

FIG. 1. Diagram showing the charging process of an internal combustion engine.

The diagram represents either a two-stroke cycle or a four-stroke cycle engine with considerable valve overlap. In a four-stroke cycle engine without valve overlap the air short-circuited V_{short} is zero and the area below the dash line is missing.



Definitions:

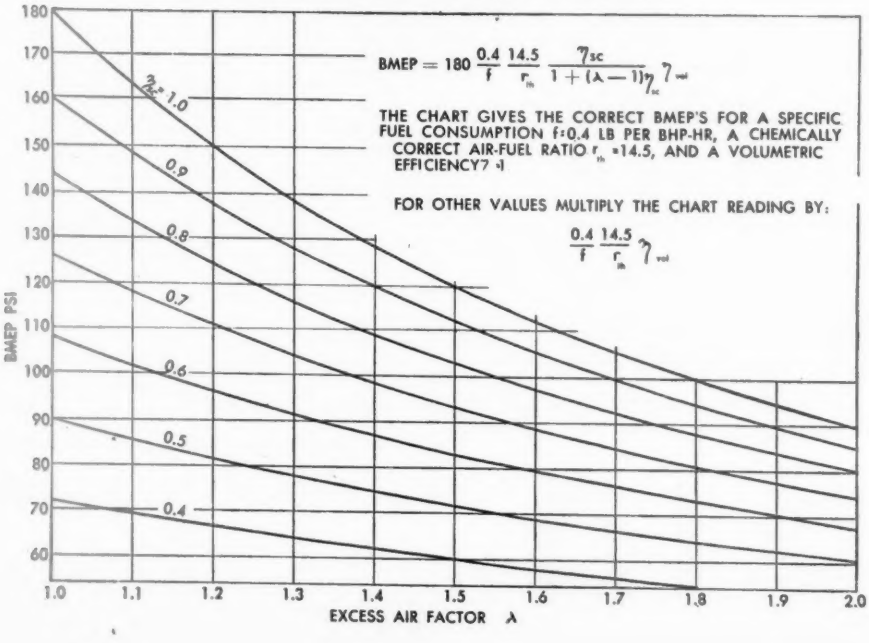
Scavenging efficiency: $\eta_{sc} = \frac{V_{ret}}{V_{ret}+V_{res}}$ Charging efficiency: $\eta_{ch} = \frac{V_{ret}}{V_{disp}}$

Volumetric efficiency: $\eta_{vol} = \frac{V_{ret}+V_{res}}{V_{disp}}$ Delivery ratio: $\angle = \frac{V_{ret}+V_{short}}{V_{disp}}$

Utilization factor: $\eta_{ut} = \frac{V_{ret}}{V_{ret}+V_{short}}$ Excess air factor: $\lambda = \frac{V_{pure}}{V_{theo}}$

FIG. 2. Relation between excess air factor and bmep.

This chart covers both four-stroke and two-stroke cycle engines of all types at any load.


BMEP = 180 (0.4/f)(14.5/r_th)(η_sc/(1+(λ−1)η_sc))η_vol
THE CHART GIVES THE CORRECT BMEP'S FOR A SPECIFIC FUEL CONSUMPTION f=0.4 LB PER BHP-HR, A CHEMICALLY CORRECT AIR-FUEL RATIO r_th=14.5, AND A VOLUMETRIC EFFICIENCY η_vol=1
FOR OTHER VALUES MULTIPLY THE CHART READING BY: (0.4/f)(14.5/r_th)η_vol
η_sc = 1.0
0.9
0.8
0.7
0.6
0.5
0.4
BMEP PSI
EXCESS AIR FACTOR λ

Gun perforation design for uniform productivity

By **WARREN J. JACKSON,** *Petroleum Engineer,*
Lane-Wells Company

RECENT studies[1] of the performance of gun-perforated wells have shown that variations in the ratio of the productivity of an open hole to that of a perforated cased hole with different numbers of perforations per foot of casing were not so great a factor as might be expected, particularly when the number of ½-in. perforations per ft exceeded five or ten, but the productivity of a well is materially reduced when less than five ½-in. perforations per ft are made in the casing. The studies have also indicated the importance of placing the perforations selectively in accordance with the permeability profile.

EXCLUSIVE

The results of one of these studies is presented by the graphs in Fig. 1. For example, with ½-in. perforations and a casing diameter of 6 in., the relative productive capacity of open hole to cased and perforated hole increases from 41 per cent to 60 per cent by doubling the number of perforations per foot of casing from two to four. The productivity is seriously reduced when the holes are exceedingly wide spaced. For perforation densities up to five or ten per foot, however, the productivity is approximately proportional to the density, that is, the greater the perforation density the greater the well productivity, particularly, when the pay formation has relatively low permeability, high viscosity crude oil, or low reservoir pressure for its depth.

● **The productivity index.** The term productivity index is used to denote the number of barrels of oil produced by a well per day per lb per sq in of differential pressure between the reservoir and the bore of the well. This is simply the daily rate of production per pound drop in bottom-hole pressure. The productivity index, or productivity factor, is thus a measure of the ability of a well to produce oil and is, therefore, an indication of the resistance to flow through the sand into the well bore.

It follows that the productivity index will be adversely affected by any resistance to flow that might result from insufficient perforations or openings in the casing. It is important, therefore, to provide sufficient perforations that will not restrict flow into the well, especially where the productivity index is used to determine the well potential for allowable calculations.

● **Insufficient perforations may reduce productivity factors.** The resistance to flow due to insufficient perforations is less noticeable in the normal operations of most wells, because the well potentials are relatively unimportant in many proration formulas, and minor reductions in well productivities due to insufficient perforations are less serious than if the wells were allowed to produce to full capacity. On the other hand, even under these conditions, it is usually important to determine the effect of the perforations on the observed productivity factors for comparison with the factors that might be predicted on the basis of core analyses.

The importance being attached to the productivity factor of wells in determining well potentials and in the general evaluation of producing formations has aroused interest in all the various factors that may influence the productivity of a well. One such factor worthy of examination is: Just how great is the effect of insufficient perforations in restricting the flow into the well. In this connection, Fig. 1 is presented as an aid to operators and engineers in estimating the effect of perforating patterns on the relative productivity of their wells.

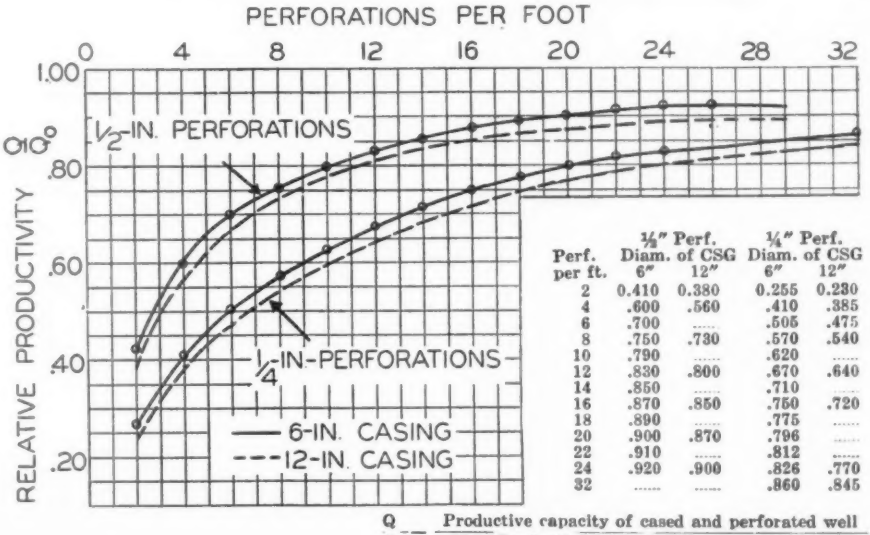
● **Use of Fig. 1.** An operator, for example, completed a well in a 10-ft section of fairly homogeneous and permeable oil sand. Casing was set through the sand and gun-perforated, the size and spacing of perforations being two ¼-in. holes per foot.

Potential tests on the well indicated a productivity factor of 2.4 bbl per day per pound drop in bottom-hole pressure, or 240 bbl per day with 100 lb difference between the static (shut-in) and flowing bottom-hole pressure on a ¼-in. choke.

Using the chart (Fig. 1), it is found that the relative productivity for a well with two ¼-in. perforations per ft in 6-in. casing (about the size in the well) is 0.255, and that six ¼-in. perforations per ft would give the well a relative productivity of 0.50. The operator may estimate, therefore, that, by adding four more perforations per ft, the productivity of the well will be about doubled (0.50/0.255) from 240 to 480 bbl per day with the 100-lb drop in bottom-hole pressure. The effect of other perforation densities can be estimated in a similar way, but it should be borne in mind that all formations will not yield additional oil and gas in accordance with this curve unless the exposed formation has the capacity to produce the additional quantity.

● **Effect of perforation density on bottom-hole pressure drops.** Fig. 2 shows the relationship that exists between bottom-hole pressure drop and the number of perforations per foot, under certain conditions in cycling operations. In the treatment of this problem, a study was made of the effect of gun perforations per foot on input and output wells in connection with the predicted performance of these wells for cycling operations. Calculation of the overall pressure drop in the wells was made on the basis of the anticipated volumes of gas to be cycled, taking into account reservoir pressure, the permeability profile of the formation, and the relative posi-

FIG. 1. Effect of number of perforations on well productivity.



Perf. per ft.	½" Perf. Diam. of CSG 6"	½" Perf. Diam. of CSG 12"	¼" Perf. Diam. of CSG 6"	¼" Perf. Diam. of CSG 12"
2	0.410	0.380	0.255	0.230
4	.600	.560	.410	.385
6	.700	.....	.505	.475
8	.750	.730	.570	.540
10	.790	.....	.620	.....
12	.830	.800	.670	.640
14	.850	.....	.710	.....
16	.870	.850	.750	.720
18	.890	.....	.775	.....
20	.900	.870	.796	.....
22	.910	.....	.812	.....
24	.920	.900	.826	.770
32	.....	.....	.860	.845

$$\frac{Q}{Q_o} = \frac{\text{Productive capacity of cased and perforated well}}{\text{Productive capacity of uncased well}}$$

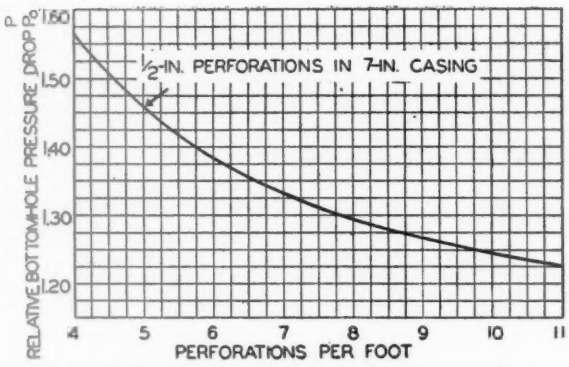


FIG. 2. Effect of number of perforations on bottomhole pressure drops in a gas cycling project.

$$\frac{P}{P_o} = \frac{\text{bottomhole pressure in cased and perforated wells}}{\text{bottomhole pressure in uncased 7-in. hole}}$$

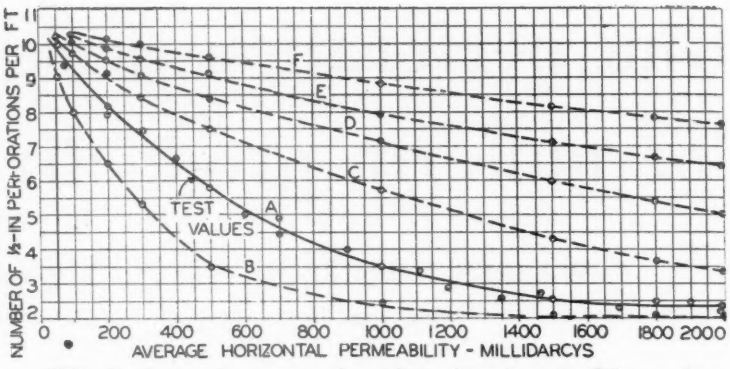


FIG. 3. Approximate number of perforations in 7-in. casing required for a reservoir with the following fluid characteristics:

TEST DATA

Curve A—(a) Formation volume factor—1.33
(b) Viscosity 0.614 centipoises
(c) Relative permeability—51%

Calculated values for other viscosities
Curve B—Viscosity 0.31 centipoises
Curve C—Viscosity 1.2 centipoises
Curve D—Viscosity 2.0 centipoises
Curve E—Viscosity 3.0 centipoises
Curve F—Viscosity 5.0 centipoises

tions of the input and output wells. This study was made by extending Muskat's treatment of a perforated casing in a radial flow problem to the factors involved in gas injection. In making these determinations all wells were treated on the basis that the flow was essentially radial in the immediate vicinity of the well bore to distances of approximately 100 ft. Muskat's solution was then employed to give the pressure drop for radial flow from the well to this point. Inasmuch as Muskat's treatment gives the ratio of the pressure drop due to perforations as compared with an open hole (for the same rate of fluid movement) by multiplying Muskat's factor by the calculated potential drop over the 100-ft radius around the input and output wells and adding those values to the potential difference calculated between these points in the sand, the overall corrected potential drop beween input and output wells was obtained.

The ratios of pressure differences using perforated casing as compared with 7-in. open hole are shown in Fig. 2. The large increase in the overall pressure drop, using four ½-in. perforations per ft, over the pressure drop for open hole completion, is quite apparent, showing a value of 57 per cent. By increasing the number of perforations to 10 holes per ft, the increase in pressure differential is kept within the range of 25 per cent. The curve is retarded in its declination for values greater than 10 perforations per ft, indicating that little is likely to be gained by increasing the perforations beyond this number.

It is also indicated that wells perforated with only four ½-in. holes per ft are produced with an excess back pressure of 25.6 per cent on the formations when compared with the same wells completed with 10 perforations per ft. This is the difference between 1 57 and 1.25 on the curve divided by 1.25 and multiplied by 100 to convert to per cent.

● **Use of curve in Fig. 2.** The curve in Fig. 2 may be used by an operator to predict the approximate effect of his well perforating patterns on the pressures required for cycling. For example, 2,000 cu ft of gas is being injected into an input well every day, but a pressure of 3000 psi is required to maintain this injection rate through the four ½-in. perforations per ft in the 20 ft section of casing set through the sand. The curve indicates that the same volume of gas might be injected with 20.3 per cent less pressure, if six more perforations were made in each foot of section. The input pressure might thus be reduced from 3000 psi to 2390 psi, or a drop of 610 psi. Similarly, the curve may be used to predict the amount of pressure increases that might be obtained by additional perforations in output (producing) gas wells.

● **More perforations needed where liners used.** In his study to determine the optimum number of perforations per foot of casing, B. C. Craft[2] compared the inlet area of various types of wire wrapped screens and slotted liners with an equivalent number of ½-in. perforations per ft. He used as a basis of these determinations the factors involved in the radial flow equation as follows:

$$P = \frac{Q\mu}{2\pi kh} \log_e \frac{r}{rw} + Pw$$

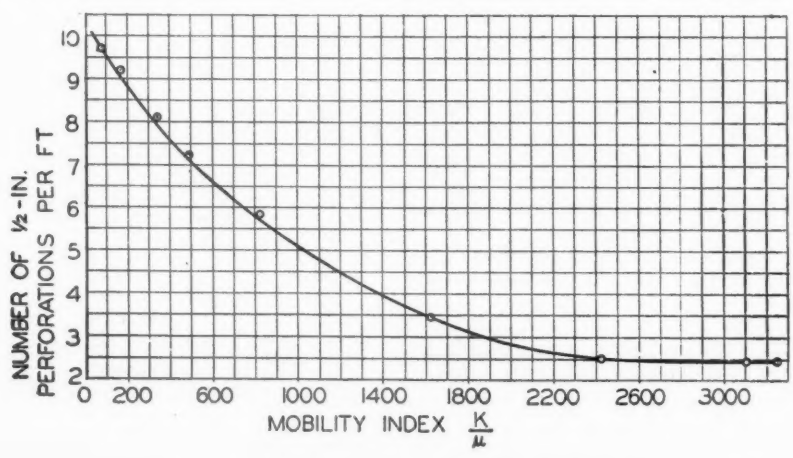
Where:

P = the pressure at the radial distance r from the well axis,
Pw = the pressure at the sand face,
Q = the rate of flow,
μ = the fluid viscosity,
h = the sand thickness,
k = the sand permeability,
r = the radial distance from the well, and
rw = the well radius.

The study led to the conclusion that the combined area of the gun perforations per foot of casing should be twice that of the opening per foot of screen pipe for the following reasons:

1. The convergence or crowding of the perforations causes pressure losses.
2. The orifice effect of the perforations wears out the screen or liner.
3. The cost of reworking wells where the screen pipe has become gas cut is usually high.

FIG. 4. Mobility index curve for the experimental data of Curve A, Fig. 3.



4. A number of the perforations may become plugged.

Achievement of the two to one ratio recommended by the study would require about ten ½-in. perforations per ft for a 3-in. screen and 13 per ft for a 4-in. screen.

● **Selective perforation patterns.** In order to obtain more uniform flow into the wells from the different layers, or sections, in an oil or gas pay zone, more operators are selectively perforating the casing through the pay zone instead of using a regular perforating pattern of so many holes per foot. Core analysis data are used where available to determine the average permeability of the various layers, or sections, in the pay zone. Perforations are then spaced in accordance with the average permeability, that is, more perforations are made opposite sections of low permeability and fewer perforations are made opposite sections of higher permeability. In this way, the tighter sections of the pay may yield more oil by having less restriction to flow.

● **Gun-perforation pattern design.** Fig. 3, curve A, is presented to show the results of field and laboratory tests that have been made to determine the approximate number of ½-in. perforations required for uniform flow into the well bore from each section of a producing formation that has variable permeability. The characteristics of the fluid in the reservoir in which these tests were made are indicated on Fig. 3. In determining the number of perforations, it was necessary to correlate the permeability and calculated productivity indices with productivity indices measured under actual flow conditions in the wells. When appreciable differences occurred, and the measured productivity index for a given rate of flow was below the calculated value, the need for additional perforations per foot was indicated.

From Fig. 3 (curve A) it will be noted that the perforation density required per ft varies inversely with the permeability. For example, six ½-in. perforations are required in a layer, or section, of the producing formation having an average horizontal permeability of 475 millidarcys, whereas a section with a permeability of 850 millidarcys should have four perforations per ft to obtain equal flow of oil having a viscosity of 0.614 centipoises at reservoir conditions.

● **Effect of viscosity on perforation requirements.** Curves B, C, D, E and F in Fig. 3 show the calculated number of perforations that are required to obtain equivalent flow of fluids having higher and lower viscosities than 0.614.

The calculations involved the use of the $\frac{K}{\mu}$ (mobility index) shown in Fig. 4. Values of $\frac{K}{\mu}$ are commonly accepted as measures of the mobility of the reservoir fluids. K is the average horizontal permeability and μ is the reservoir fluid viscosity. These curves are presented to show the effect of the viscosity of the reservoir fluid upon the number of perforations used with respect to the permeability.

It is evident from these curves that the perforation density required per ft varies directly with the viscosity, that is, the higher the viscosity the higher the number of perforations required, and vice versa. An accurate measurement of viscosity is important, not only at original reservoir conditions, but also at pressures and temperatures below the saturation point, so that enough perforations can be made initially to take care of the increased viscosity in the later life of the reservoir.

In determining the number of perforations suitable for the permeability profile of a well, on Fig. 3, for example, about 3.5 holes per ft are indicated on Curve A for a reservoir fluid viscosity of 0.614 centipoises with an average horizontal permeability of 1000 millidarcys; whereas, on Curve C, for a reservoir fluid viscosity of 1.2 centipoises, about 5.7 holes per ft are indicated for the same permeability. Thus, six perforations per ft should be made originally to allow for the increase in viscosity that will develop as the reservoir pressure declines and the gas comes out of solution.

The curves in Fig. 3 show clearly the need for additional perforations per foot with respect to increases in reservoir fluid viscosities. They suggest that the predicted increases in reservoir fluid viscosity should govern the perforating pattern rather than the viscosity under initial reservoir conditions.

The influx of water in the later producing life of a field, which almost always has a lower viscosity than the oil, will affect the mobility of the reservoir fluids and result in producing a larger volume of fluid through a given number of perforations at comparable reservoir pressures.

● **Perforation pattern charts for other reservoirs.** Similar perforation pattern charts can be prepared for wells in other reservoirs where the permeability and fluid charactertistics are known. When all the factors are correlated with field tests of wells with different perforation densities, a perforation pattern chart can be devised that will provide a low pressure differential between the reservoir and the well bore and result in more uniform flow of the liquids from the formation into the well. The number of perforations per foot as indicated on Fig. 3 will necessarily vary with each type of formation, reservoir permeability, and reservoir fluid characteristics, especially the viscosity of the oil. Therefore, Fig. 3 is submitted only as a guide for devising similar perforation patterns.

● **Production efficiency increased by selective perforating.** The use of core analysis and reservoir fluid data in this method for the design of a selective perforating spacing pattern results in higher production efficiency of these wells upon completion, and is of increasing benefit in the later life of these wells as the reservoir pressure declines. The productivity index values of these wells may be predicted by the following tentative equation[3]:

$$I = 5.9 \times 10^{-4} \frac{Kh}{\mu FV}$$

Where:

I = productivity index, in bbl oil per day per psi pressure differential.

K = average permeability of exposed thickness in millidarcys.

h = exposed formation thickness in ft

μ = viscosity of oil at reservoir pressure and temperature in centipoises.

FV = formation volume factor, volume occupied at saturated reservoir conditions by one unit volume of stock tank oil.

No formula or criterion has been developed to date, however, that can be applied generally in the formulation of a perforating plan to meet all conditions. There are sufficient data and information available as a result of the many individual reservoir studies, however, that can be applied in determining the perforating density that will provide productivity factors suitable to reservoir conditions.

References.

1. "The Effect of Casing Perforations on Well Productivity," M. Muskat, *A.I.M.E. Translations*. 1943.
2. "Gun Perforated Well Completions," Benjamin C. Craft, *The Petroleum Engineer*, November, 1943.
3. "Productivity Index and Measureable Reservoir Characteristics," James A. Lewis, William L. Horner, Marion Stekoll. Presented at A.I.M.E. Petroleum Division, Dallas, Texas, October, 1941.
4. "The Effect of Gun-Perforating Density on Well Productivity," Warren J. Jackson and C. E. Shilcutt, *Tomorrow's Tools Today*, Lane-Wells Company, Fourth Quarter, 1946, Vol. XII, No. 4.
5. "The Viscosity of Air, Water, Natural Gas, Crude Oil and Its Associated Gases at Oil Field Temperatures and Pressures," Carlton Beal, *A.I.M.E. T.P. 2018, Transactions*, 1946, Vol. 165.
6. "Measurements of the Viscosities of Oils Under Reservoir Conditions," C. R. Hocott and Stuart E. Buckley, A.I.M.E. T.P. 1220, *Transactions*, 1941, Vol. 142.

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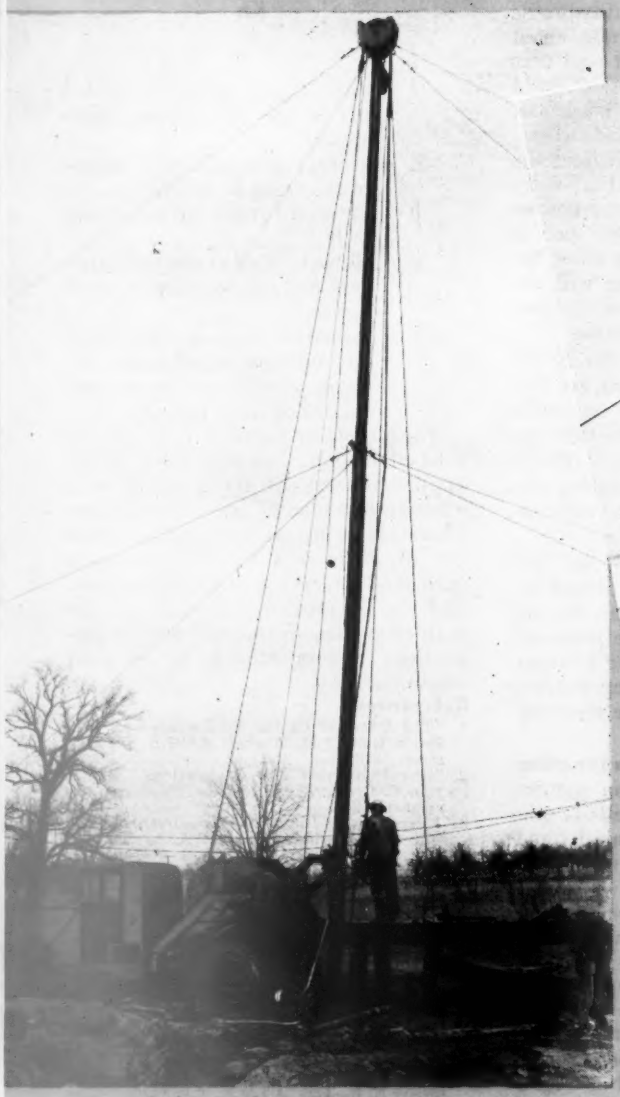
Senate committee reports ready

Senator Joseph C. O'Mahoney, chairman of the Senate petroleum resources committee, announced that copies of the final report of the committee are now available at the Government Printing Office.

The report goes extensively into the need for a national policy. Senator O'Mahoney said that because a limited supply of the document has been printed it will be necessary to place orders immediately. The superintendent of public documents at the Government Printing Office said the report will be sold at 15 cents a copy or $64.85 a thousand.

"Cardwell" Mobilhoist is easy to drive. Roadability is excellent over rough leases or in traffic. Mobilhoist is equipped with four-wheel hydraulic brakes and has a 35 m.p.h. road speed. When duals and cathead are removed, width is within 8-foot road limits.

MOBILHOIST



Double drum Mobilhoist with 48-foot single leg telescoping mast "drilling-in" a 3300-foot rotary well. 55-foot single leg mast is available. Dual wheels make it easy for Mobilhoist to get on muddy locations.

Mobilhoist with 55-foot double leg telescoping mast "drilling-in" a rotary drilled well with cable tools. Mast is carried on trunnions of Mobilhoist and is raised and telescoped by single line from hoist drum. Mast is transported with lines and block reeved.

ANNUAL PIPE LINE NUMBER

1947—Pipe line industry's banner year

By **FRANK H. LOVE,** *Managing Editor*

THE pipe-line industry's banner year, in point of construction, will be 1947. Already under way and planned are projects that assure a greater mileage than the previously record-breaking year of 1946.

EXCLUSIVE

Now being built or planned for the United States by pipe-line companies is a total of almost 20,000 miles of pipe line. This includes 3953 miles of crude oil lines, 1968 miles of products lines, 3779 miles of natural gas pipe lines authorized by the Federal Power Commission, and 9807 miles of natural gas line applications before FPC. Not all the last may be authorized and inability of manufacturers to deliver materials may be a limiting factor as it was in 1946; the possibilities, nevertheless, are apparent.

An idea of what this means in regard to money outlay can be gained from the estimated cost figures that usually are included in an application for permit to the Federal Power Commission. Cost of constructing the 3779 miles of gas pipe lines authorized by FPC is estimated at $246,235,804. The 9807 miles, applications for construction of which are now before FPC, would cost in excess of $577,030,934. In the latter group, cost figures were not given for Tennessee Natural Gas Lines, Inc., 428 miles, including main line and laterals.

It should be mentioned also that in some few instances mileages and costs overlap between 1946 and 1947, i.e., certain projects begun last year will be completed this year.

This enormous construction program is the outgrowth of several factors. Operators have not yet caught up with construction that was retarded during the war, the normal requirements of new field outlets are being met, and there is a noticeable increase in the use of natural gas for industrial and domestic consumption. Moreover, there is increasing use of pipe lines for transportation of finished products to consuming centers.

Noticeable among the 1947 projects are a number of long lines. Already in its early construction stages is the 1202-mile Texas-California gas line from West Texas to Los Angeles. El Paso Natural Gas Company is laying 988 miles of 24-in. and 26-in. pipe from West Texas to Blythe, California, and Southern California Gas Company and Southern Counties Gas Company 214 miles of 30-in. from Blythe to Los Angeles.

Recently announced by The Texas Pipe Line Company and Shell Pipe Line Corporation are plans for joint construction of a 500-mile crude oil line having a normal capacity of 150,000 bbl a day. This line will extend from the Permian Basin of West Texas and Southeast New Mexico to Cushing, Oklahoma. At Cushing connections will be made to The Texas-Empire Pipe Line Company system, which extends to Lockport and Lawrenceville, Illinois, and East Chicago, Indiana, and to Shell's line, which extends to Wood River, Illinois. The line, to be of 20, 22, and 24-in. pipe, will be the largest U. S. crude oil line yet constructed with private capital, according to Shell and Texas Company officials who made the announcement.

In gas lines, Memphis Natural Gas Company has recently applied for permission to construct a 24-in. line from East Texas gas fields to Green County, Pennsylvania, at a point near Pittsburgh. This line would have a capacity of 300,000,000 cu ft a day and would be 1016 miles in length. It would be of 24-in. pipe and cost an estimated $63,300,000.

Further news of significance to the pipe-line industry since the turn of the year was the sale in February of the Big Inch and Little Big Inch pipe lines to the Texas Eastern Transmission Company by War Assets Administration for $143,127,000. Of additional interest was the subsequent statement by officials of Texas Eastern that $40,000,000 would be spent for compressors and other equipment to provide a capacity of 425,000,000 cu ft a day.

In foreign fields, increased pipe-line construction also is in the offing. Although preliminary surveys are being made for the 1050-mile Trans-Arabian Pipe Line, actual construction likely will not begin until 1948. Projected for 1947 are the 225-mile line of Yacimientos Petroliferos Fiscales Bolivianos, Iraq Petroleum Company's 1000-mile looping program, the 325-mile products line in Colombia of Tropical Oil Company, and the 77-mile line in Venezuela of Socony-Vacuum Oil Company of Venezuela.

The government of Argentina would like to lay a 1200-mile line from the Comodoro Rivadavia field to Buenos Aires, according to Senor Teofilo Tabanera, sub-director of the Argentina government gas service, who is in the United States trying to purchase pipe. At last reports, Senor Tabanera was having difficulty due to the great demand for pipe at the present time.

Below are tabulated projects under way and proposed.

Crude Oil Lines

The Texas Pipe Line Company and Shell Pipe Line Corporation—500-mile, 20, 22, and 24-in. lines from Permian Basin of West Texas and Southeast New Mexico, to Cushing, Oklahoma.

Magnolia Pipe Line Company—650 miles, 20 in., Corsicana, Texas, to Patoka, Illinois.

Humble Pipe Line Company—43 miles, 6 in., Pittsburg field; Camp County, Texas, to Longview.

Sinclair Refining Company—50 miles, 18-in., loop to trunk system in Kansas.

Atlantic Pipe Line Company—50 miles, 8 in., West Texas.

Standish Pipe Line Company—289 miles, 12 in., Goldsmith to Borger, Texas.

Stanolind Pipe Line Company—75 16 in., West Texas extension.

Stanolind Pipe Line Company—197 miles, 12 and 16 in., loops between Cas-

per, Wyoming, and Freeman, Missouri.

Stanolind Pipe Line Company—approx. 120 miles, 12 in., Rangely, Colorado, to Wamsutter, Wyoming.

Stanolind Pipe Line Company—approx. 115 miles, 10 in., Wamsutter to Casper, Wyoming.

Stanolind Pipe Line Company—484 miles, 20 in., loops between Drumright, Oklahoma, and Whiting, Indiana.

Phoenix Pipe Line Company—600 miles, 8 in., Permian Basin area to Phoenix, Arizona.

Mid-Way Pipe Line Company—600 miles, Permian Basin area to Oklahoma and Kansas.

The Texas Pipe Line Company—80 miles, 16 in., West Columbia to Houston.

The Texas Pipe Line Company—100 miles, 22 in., Houston to Port Neches-Port Arthur, Texas.

Products Lines

Cosden Petroleum Corporation—225 miles, 4 in., Big Spring to Weatherford, Texas.

Shell Pipe Line Corporation—100 miles, 6 in., Sheridan to Deer Park, Texas.

Phillips Petroleum Company and Shamrock Oil and Gas Company—365 miles, 6 in., Borger to Denver.

Wyco Pipe Line Company—267 miles, 8 in., Casper to Cheyenne, Wyoming, to Denver Colorado.

Magnolia Pipe Line Company—150 miles, 12 in., Beaumont to Hearne, Texas.

The Texas Pipe Line Company—150 miles, 10 in., Hearne to Dallas-Ft. Worth area.

The Texas Pipe Line Company—50 miles, 6 in., between Dallas and Ft. Worth.

Sinclair Refining Company—250 miles, 6 in., Corpus Christi to Austin to San Antonio, Texas.

Connecticut Pipe Line Corporation—40 miles, 8 in., New Haven to Hartford.

Great Lakes Pipe Line Company—54 miles, 8 in., Ponca City to Barnsdall, Oklahoma.

Socony-Vacuum Oil Company, Inc.—235 miles, 6 in., Sioux Falls, South Dakota, to Fargo, North Dakota.

Sunray Oil Corporation—83 miles, 8 in., Allen to Drumright, Oklahoma.

Natural Gas Pipe Lines (FPC authorized)

Mississippi River Fuel Corporation—265 miles, 22 in. loops, and 14 miles 12-in. loops. Additional compressor units. Estimated cost: $11,605,628.

Ohio Fuel Gas Company—88 miles, 16 in., in Lorain, Fairfield, Licking, and Knox counties. Underground natural gas storage project and compressor stations also authorized. Estimated cost: $3,370,100.

Michigan-Wisconsin Pipe Line Company—1069 miles, 22 and 26 in., from Hansford County, Texas (Hugoton field) to Big Rapids, Michigan. Also compressor stations. Estimated cost: $52,618,823.

Hope Natural Gas Company—58 miles, 20-in. loops in West Virginia. Also new compressor units and other facilities. Estimated cost: $4,552,000.

Panhandle Eastern Pipe Line Company—391 miles, 18 and 26 in. loops, in Kansas, Missouri, and Illinois. Additions to compressor stations and company's field system. Estimated cost: $33,057,000.

Natural Gas Pipeline Company of America and Texoma Natural Gas Company—146 miles, 16, 24, and 26-in. loops. Also compressor installations. Estimated cost: $23,493,987.

Michigan Gas Storage Company—150 miles, 12 and 24 in., Freedom Junction, Michigan, to Winterfield and Cranberry Lake fields. Also other facilities. Estimated cost: $20,107,549.

El Paso Natural Gas Company—988 miles, 24 and 26 in., West Texas to Blythe, California. Estimated cost: $53,300,000.

Southern California Gas Company and Southern Counties Gas Company of California—214 miles, 30 in., Blythe to Los Angeles, California. Estimated cost: $16,225,000.

Tennessee Gas and Transmission Company—410 miles, 24 and 26-in. loops, from Texas to West Virginia. Additional compressor horsepower. This work is partially completed. Estimated cost: $27,405,717.

Natural Gas Lines (FPC applications)

Hope Natural Gas Company—1128 miles, 22 in., Hugoton field, Kansas, to Kanawha County, West Virginia. Also laterals and compressor capacity. Estimated cost: $54,225,216.

Alabama Tennessee Natural Gas Company—66 miles, 10 in., Tennessee to Muscle Shoals, Alabama. Estimated cost: $1,350,186.

Metropolitan Eastern Corporation—825 miles, 18 in., and compressor equipment. Carthage, Texas, to Hamilton County, Ohio. Estimated cost: $23,500,000.

Mid-Continent Gas Transmission Company—400 miles of partially looped 26-in. line from Woods County, Kansas, to Kansas City, Missouri; 436 miles 26-in. from Kansas City to St. Paul, Minnesota; and new compressor stations. Estimated cost: $72,600,000.

Trans-Continental Pipe Line Company—1380 miles, 26 in. Hemphill, Texas, to Eastern Seaboard. Estimated cost: $130,000,000.

Cities Service Gas Company—405 miles, 26 in., Hugoton field, Kansas, to Kansas City, Missouri. Replacement of 44 miles of 16-in. with 20-in. Additional compressor units. Estimated cost: $24,308,050.

Northern Natural Gas Company—185 miles, 16 in., loops and mainline. Additional compressor units. Estimated cost: $12,441,000.

Natural Gas Pipeline Company and Texoma Natural Gas Company—145 miles, 16 and 26 in., loops and new line. Additional compressors. Estimated cost: $23,718,900.

Hope Natural Gas Company—58 miles, 20 in. loops, and additional compressor equipment, in West Virginia. Estimated cost: $4,600,000.

Southern Natural Gas Company—209 miles, 4, 8, 20, and 22 in., mostly loops, some extensions; additional compressors. Estimated cost: $8,232,120.

Hope Natural Gas Company—59 miles, 12 in., in West Virginia. Additional compressors. Estimated cost: $4,700,000.

Tennessee Gas and Transmission Company—105 miles, 8 and 10 in., Denver, Colorado, to Cheyenne, Wyoming. Estimated cost: $1,415,000.

New York State Natural Gas Corporation—166 miles, 12, 14, and 16 in. and compressor units, in Pennsylvania. Estimated cost: $5,250,000.

Austin Field Pipe Line Company—202 miles, 6, 10, 24, and 26 in., in Michigan. Compressor station. Estimated cost: $7,188,592.

Colorado Interstate Gas Company—257 miles, 16 and 20 in., Hugoton field, Kansas, to Denver, Colorado. Compressor facilities. Estimated cost: $11,630,400.

Penn-York Natural Gas Corporation—65 miles, 10 and 14 in., York, New York, to Lewiston, New York. Compressor station. Estimated cost: $1,235,610.

Tennessee Natural Gas Lines, Inc.—287 miles, 12 and 16 in., plus 141 miles of 3 and 4 in. laterals—total 428 miles. In Tennessee. Cost not listed in docket.

United Fuel Gas Company—70 miles, 20 in., in West Virginia. Estimated cost: $2,970,000.

United Fuel Gas Company and Ohio Fuel Gas Company—100 miles, 20 in., Ceredo, West Virginia, to Fairfield County, Ohio. Estimated cost: $4,398,620.

Mississippi River Fuel Corporation—231 miles loops, 10, 12, 22 in., between Perryville, Louisiana, and St. Louis, Missouri. Estimated cost: $10,200,000.

Memphis Natural Gas Company—1016 miles, 24 in., East Texas to Green County, Pennsylvania. Estimated cost: $63,300,000.

Columbia Gas and Electric Corporation (Charleston and Pittsburgh groups)—398 miles, 14 and 24 in., in West Virginia, Maryland, Pennsylvania, and New York. Also compressor station installations. Estimated cost: $25,492,040.

Kansas-Nebraska Natural Gas Company, Inc.—47 miles connecting line, Cambridge to Cozad, Nebraska. Estimated cost: $230,200.

Northern Natural Gas Company—583 miles, 20, 24, and 26 in. loops, in Kansas, Iowa, and Nebraska. Also additional compressor horsepower and a dehydration plant. Cost: $24,500,000.

Foreign Pipe Lines

Yacimientos Petroliferos Fiscales Bolivianos—225-mile, 6-in. oil line in Bolivia.

Trans-Arabian Pipe Line Company—1050 miles, 28 and 30 in. oil line. (Construction will begin in 1948).

Iraq Petroleum Company—1000 miles of 16-in. loops, Kirkuk, Iraq, to Haifa, Palestine, and Haditha, Iraq, to Tripoli, Lebanon.

Socony-Vacuum Oil Company of Venezuela—77-mile, 12-in. oil line, Oficina to Puerto la Cruz, Venezuela.

Tropical Oil Company—325 miles products line in Colombia.

Argentina Government — 1200 miles. Comodoro Rivadavia field to Buenos Aires.

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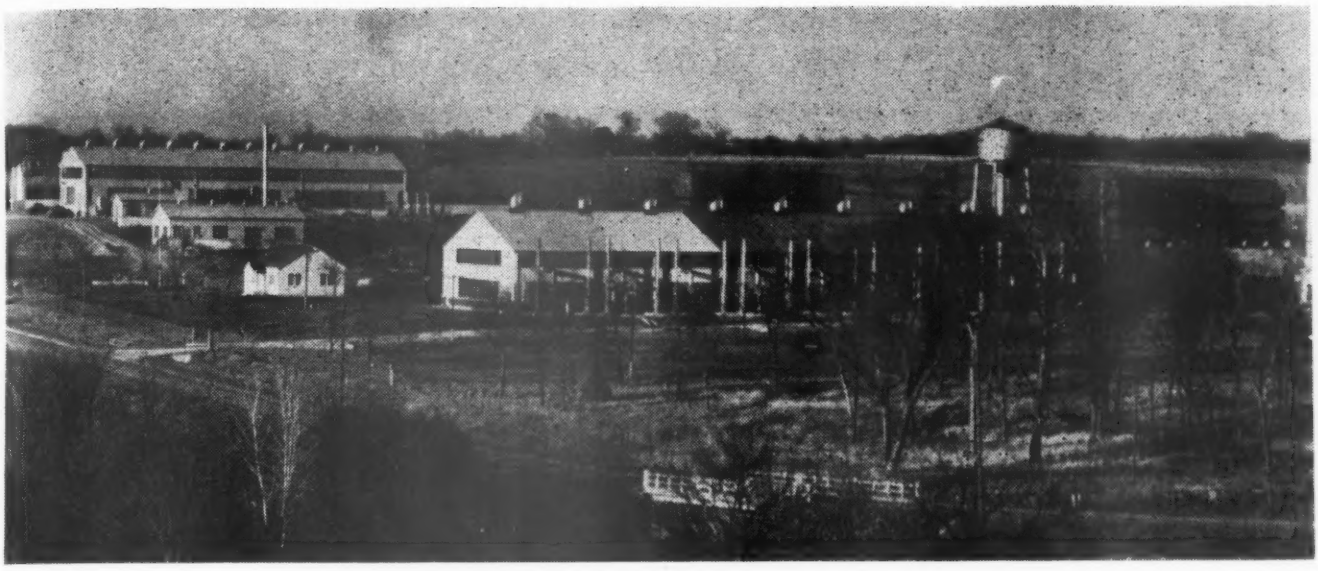


General view of Panhandle Eastern's Louisburg, Kansas, station.

Panhandle Eastern continues to expand

By **C. H. M. BURNHAM,** *Vice President and Chief Engineer,*
Panhandle Eastern Pipe Line Company

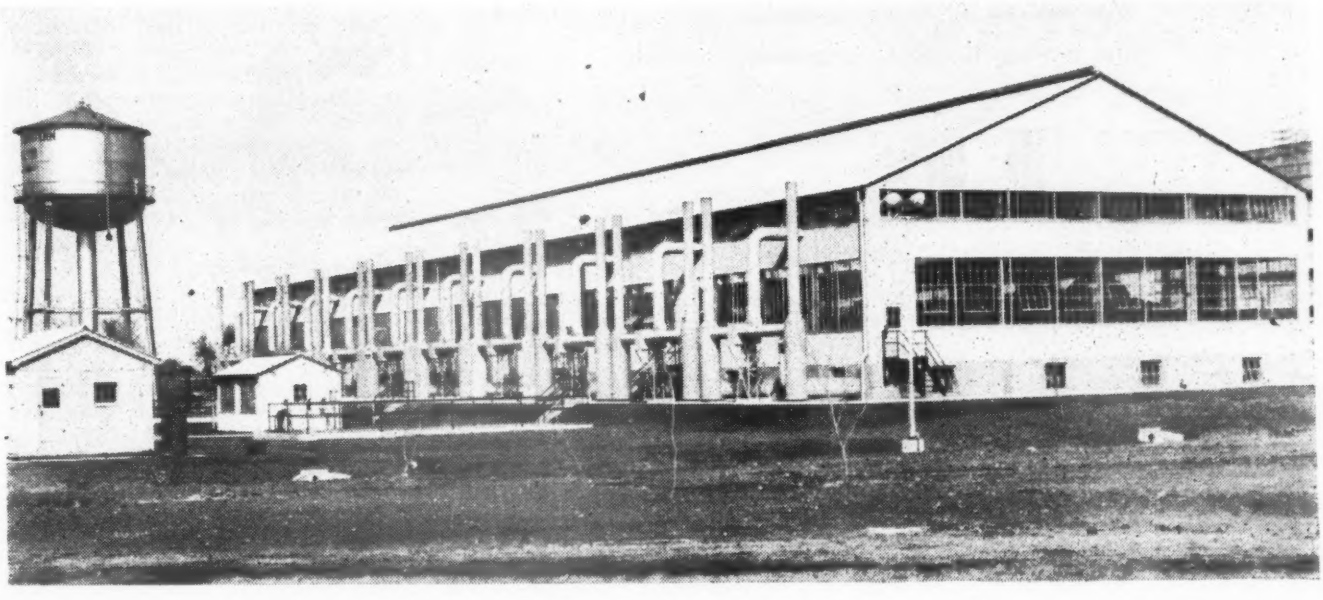
IN order to meet the requirements of its rapidly growing markets Panhandle Eastern Pipe Line Company is continuing to expand its gas transmission facilities. This can be judged from its 1946 construction, now nearing completion, as well as its 1947 program, a certificate of convenience and necessity for which was granted only recently by the Federal Power Commission. How quickly the 1947 program can be carried out depends largely on the availability of construction materials, particularly pipe.

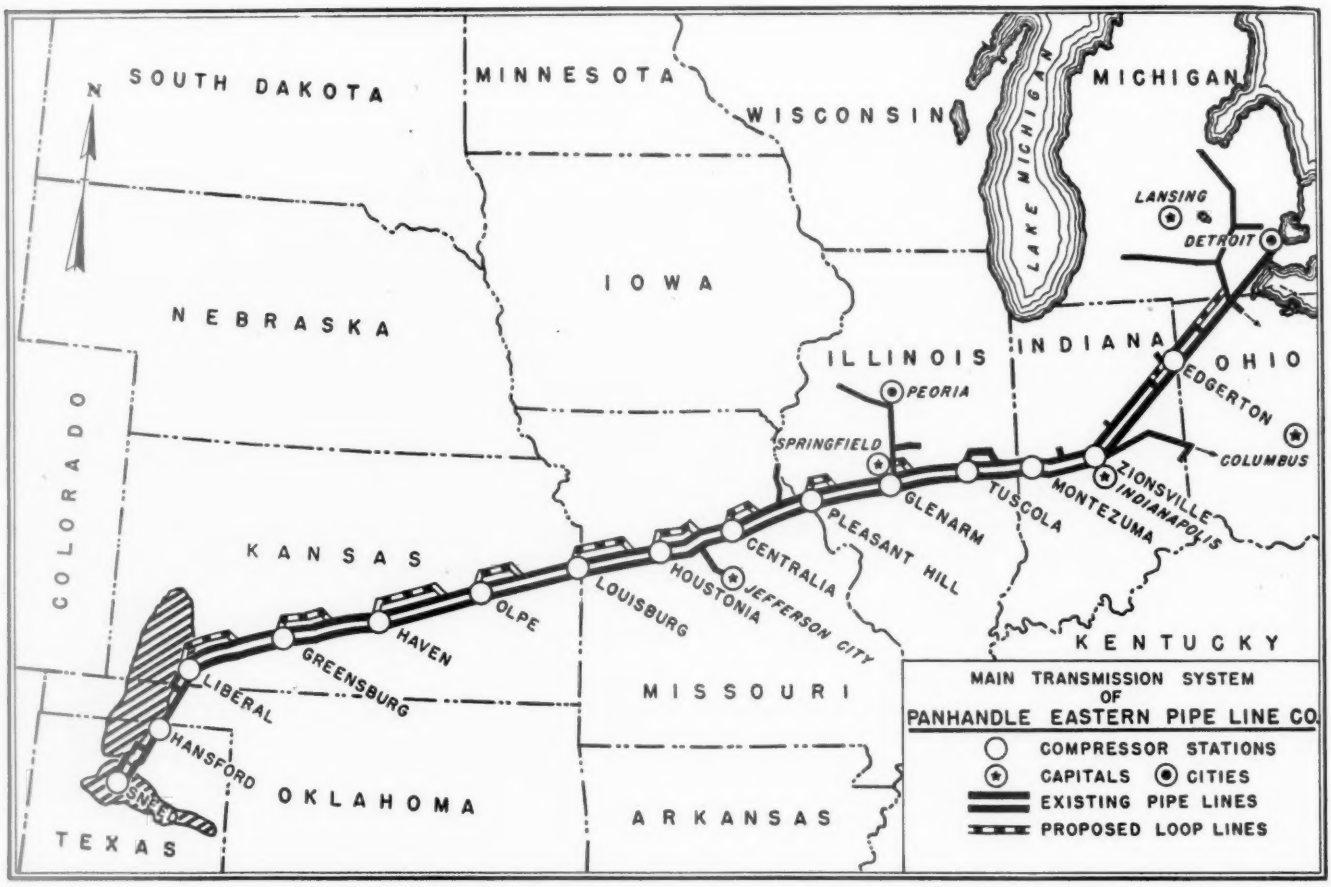
EXCLUSIVE

The 1946 construction work, now in various stages of completion along this company's main line, includes eight 1600-hp vertical gas-engine-driven compressors, two of which are being installed in each of Panhandle Eastern's compressor stations at Glenarm and Tuscola, Illinois, and at Zionsville and Edgerton, Indiana; and one 800-hp unit of similar design in its Olpe, Kansas, compressor station.

In the area where Panhandle Eastern Pipe Line Company produces or purchases its natural gas requirements a new compressor station, powered by three 1000-hp vertical engines, has been built near Sunray, Texas, and 2400-hp and 1600-hp additions have been built

Closeup view of compressor building at Houstonia, Missouri, station.





at its existing Hansford, Texas, and Hugoton, Kansas, stations.

Late in 1946 a temporary certificate was granted by the Federal Power Commission to install one standby engine at each of eight of the company's existing compressor stations. Contracts for the installation of these standby engines have been let and work is now in progress. These engines are located at the following compressor stations: Greensburg, Kansas; Haven, Kansas; Olpe, Kansas; Louisburg, Kansas; Houstonia, Missouri; Centralia, Missouri; Pleasant Hill, Illinois, and Montezuma, Indiana.

Pipe line construction during 1946 consisted principally of the building of 51 miles of 18-in. OD solid welded line connecting the new Sunray compressor station (referred to above) into the company's system at Hansford station. This line is solid welded and is constructed for high pressure operation. In addition to the line from Sunray, Texas, the first of the company's third line loops, as is shown on the accompanying drawing, was built east of Tuscola, Illinois. This loop is 24 miles long and is constructed of 26-in. OD pipe. It is constructed for an eventual working pressure of 900 psi.

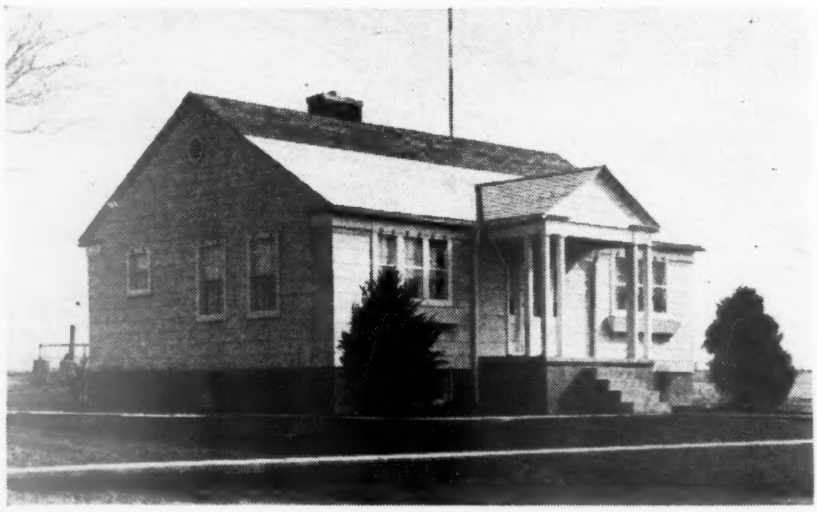
The accompanying drawing also shows additions to the Panhandle Eastern Pipe Line Company's system east of Liberal, Kansas, which will be constructed under a certificate of convenience and necessity granted November 30, 1946, by the Federal Power Commission. These facilities consist of additional loop lines to be built on the discharge side of each of the following compressor stations: Liberal, Kansas; Greensburg, Kansas; Haven, Kansas; Olpe, Kansas; Louisburg, Kansas; Houstonia, Missouri; Centralia, Missouri; Pleasant Hill, Illinois, and Glenarm, Illinois.

The second line between Zionsville compressor station and Edgerton compressor station will be completed by the addition of some 28 miles of 26-in. pipe, and the loop line on the outlet side of Edgerton compressor station will be extended for a distance of approximately 40 miles. All in all, the above pipe line construction will total some 360 miles of 26-in. OD pipe line. The third line loops will be built for high pressure operation (900 psi), however, it is not proposed to operate them at this pressure until they are further extended, as market requirements might dictate.

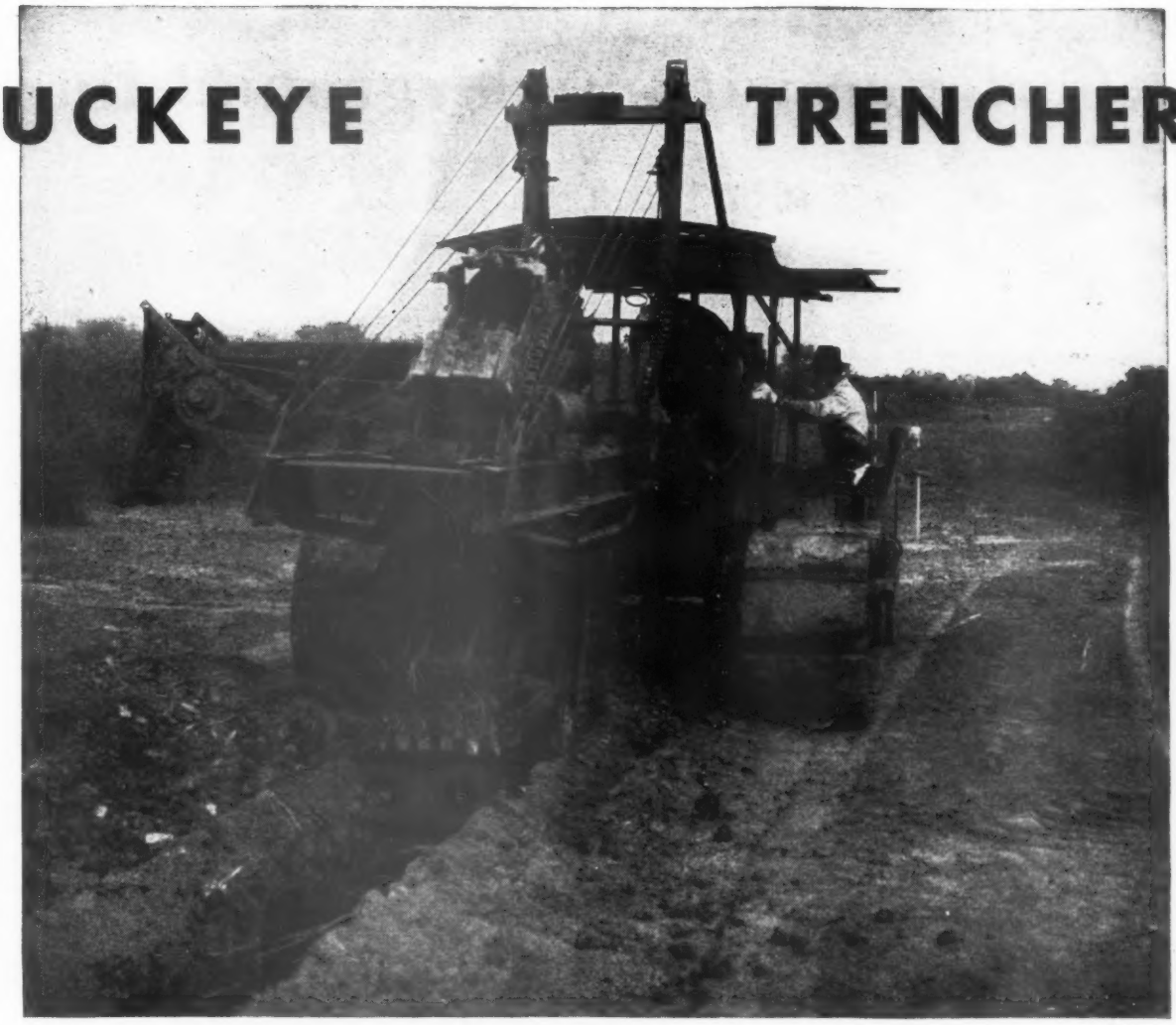
The 1947 construction program also includes numerous additions to the company's field system. These are not shown on the accompanying map, but consist principally of additions to existing field stations and the reinforcement of some of the present pipe lines leading into its main gathering system.

Panhandle Eastern Pipe Line Company proposes to spend $33,057,000 on this expansion program, much of which will be completed late in 1947 or early 1948. ★★★

Typical cottage provided for operating personnel.



BUCKEYE TRENCHERS



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Experience with underground lines

By **M. C. ALCORN,** Shell Oil Company

EXCLUSIVE

TEN years ago in December, 1936, Shell Oil Company, Inc., completed the construction of a pipe-line system in California from the Bakersfield area in the South San Joaquin Valley to the Martinez refinery in the San Francisco Bay area. This system consisted of several gathering lines from oil fields in the South San Joaquin Valley to a central tank farm near Bakersfield, 90 miles of combination 10-in. and 12-in. pipe line between the Bakersfield tank farm and the Coalinga tank farm, and 170 miles of 8, 10, and 12-in. line between the Coalinga tank farm and the Martinez refinery. This 170-mile section of pipe was installed parallel to, and about 3 ft from, an existing line that had been constructed in 1914-15.

Prior to construction of the pipe-line system in 1936, soil resistivity and corrosivity surveys were conducted along the proposed route between Bakersfield and Coalinga. The soil resistivities were plotted in graph form with notations regarding corrosivity and a decision was made to apply protective coating to all pipe to be buried in soil having a resistivity of less than 1000 ohms per cu cm. This resulted in coating 64 per cent of the 90 miles of pipe.

Between Coalinga and Martinez a pipe line had been in operation since 1915, and the records were studied carefully to determine the location of "hot spots" from corrosion experience. As a result, protective coating was applied to only 4 per cent of 170 miles of new construction.

Of a total of 318 miles of all sizes of pipe in both trunk and gathering lines, which were laid in 1936, protective coating was applied to only 75 miles. This procedure was adopted in order to save a substantial amount of money in initial investment in protective coating on the theory that the interest on the money and only a small amount of this saving would be required in maintenance throughout the years to recondition isolated "hot spots," which would be located by the occurrence of leaks.

Practically all the protective coating applied in this 1936 program consisted of a coal tar primer followed by a coat of coal tar enamel covered by an unbonded asbestos felt wrap to serve as a reinforcement, over which a coat of asphalt enamel was applied covered by an outside bonded asbestos felt shield. Most of the coating applied since 1936 has been an asphalt primer followed by one coat of asphalt enamel 5/32 in. thick covered by an outside bonded asbestos felt shield. Approximately 45,000 ft of mastic coating has been applied by the "over the trench" methods.

THE AUTHOR

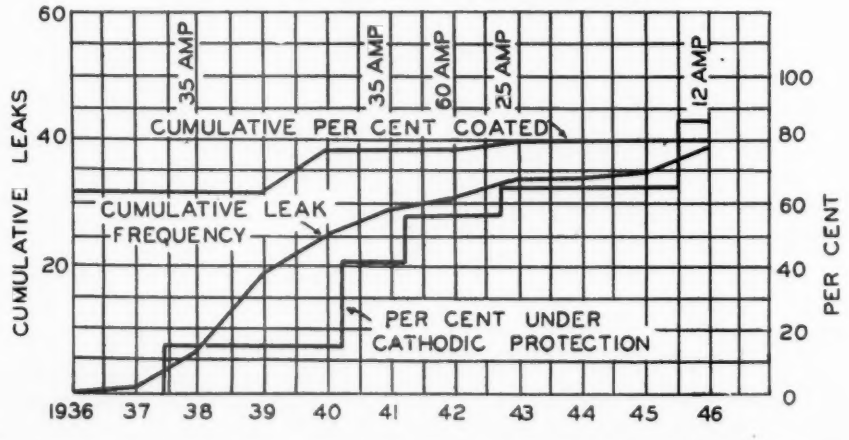
M. C. Alcorn, assistant pipe line manager for Shell Oil Company, Inc., in California, received his degree in civil engineering from Purdue University in 1923. After working two years in the State of Nevada with a private engineering firm and then with the Nevada Highway Department, he entered the service of Shell Oil Company in 1926 in the survey and drafting department. After transferring to the pipe line division in 1928, he assisted in the design and construction of Shell's San Joaquin Valley oil transportation system in 1936 and of the Ventura-Wilmington pipe line in 1941. He served as division engineer and superintendent of Shell's southern district pipe lines from 1939 until 1946, when he was promoted to his present position.

The results of the experience of ten years on the trunk lines are shown in Figs. 1, 2, and 3. Experience on the gathering lines is comparable, but the results have not been shown in graph form. Fig. 1 shows the cumulative leaks that have occurred on the 90-mile Bakersfield-Coalinga pipe line, the cumulative percentage of the line to which protective coating has been applied, and the cumulative percentage of the line to which cathodic protection has been applied, all in relation to time throughout the ten-year period. The cathodic protection amperage added during each year is indicated on the graph. It will be noted that the first leaks occurred within one year after construction and that application of cathodic protection was begun immediately after the first leaks occurred. The leaks that began to occur one year after installation were in uncoated pipe. Leaks began to occur in the coated pipe after five years of service, and ten leaks have occurred in coated pipe between Bakersfield and Coalinga in the last five years. The leak frequency has been reduced and maintained satisfactorily on this line by the application of cathodic protection and increasing the amount coated from 64 to 80 per cent.

The cumulative leak frequency, percentage coated, and percentage under cathodic protection on the 170-mile section of 8, 10, and 12-in. pipe line constructed between Coalinga and Martinez in 1936 are shown in Fig. 2. Leaks began to occur in the uncoated pipe in the second year after construction. The leak frequency continued at a straight line rate between 1938 and 1942, after which it was reduced by the effect of cathodic protection and the fairly extensive reconditioning and protective coating program carried out between 1940 and 1943.

The 170-mile 8-in. and 10-in. pipe line between Coalinga and Martinez, which was constructed in 1914-15, was orig-

FIG. 1. Bakersfield-Coalinga 10 and 12-in. pipe line constructed in 1936, 90 miles total length.



The economics of corrosion-proof pipelines

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Modern application and electrical inspection
Cathodic protection

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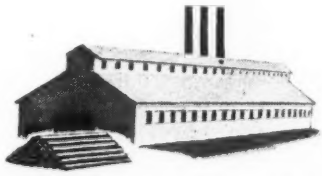
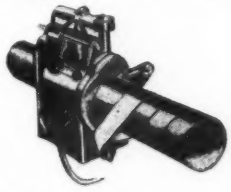
Over the years, uniformly satisfactory results have been obtained when Barrett Coal-tar Enamels have been applied by modern methods, and electrically inspected, to insure continuity of the electrical insulation.

Protection applied in transit



Modern equipment for the proper application of primers and enamels over mechanically cleaned pipe is available at numerous application contractors' plants, which apply Barrett protective coating systems while the pipe is in transit to your destinations.

Protection applied in the field



Thousands upon thousands of miles of pipelines have been protected with Barrett primers, enamels and asbestos felts, application being made over the ditch with modern traveling coating equipment and with increasing efficiency and low costs.

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inally coated over the entire distance with a coal tar primer and a coal tar enamel without reinforcement or shield. Fig. 3 indicates that the leak frequency on this pipe line has been controlled quite satisfactorily by cathodic protection and a relatively small amount of reconditioning and new protective coating since 1936; however, there has been considerable evidence that the high leak frequency of the uncoated pipe constructed in 1936, as shown in Fig. 2, and the low leak frequency of the pipe constructed and lightly coated in 1914, as shown in Fig. 3, may have been influenced to some degree by the new uncoated pipe having been laid parallel, and close, to the old pipe. The new line was anodic to the old line and may have increased the leak frequency of the new while decreasing the leak frequency of the old.

In looking back over the ten years' experience, it is found that some conditions have changed and other conditions have arisen during the period that have had a very important effect upon the final economics of laying this system of pipe lines uncoated. These are:

1. The cost of reconditioning pipe and application of protective coating has increased to a great extent since 1936. Had costs remained at the 1936 level, the economic record of the procedure would be much better than it is today.

2. Considerable and unexpected agricultural irrigation activities over the right-of-way developed during the war years, which increased the corrosivity of the soil.

3. Pipe line throughput and pressures were increased to the utmost throughout the war, so that in order not to have undue interruption of service more reconditioning work may have been done than required to obtain equal effect upon the leak frequency curve. This is illustrated in Fig. 2 by the leak frequency continuing to decline after 1943 as the amount of reconditioning also declined. This is the result of concentrating reconditioning work in the areas where leaks occurred rather than attempting to anticipate the "hot spots" by inspection and observation.

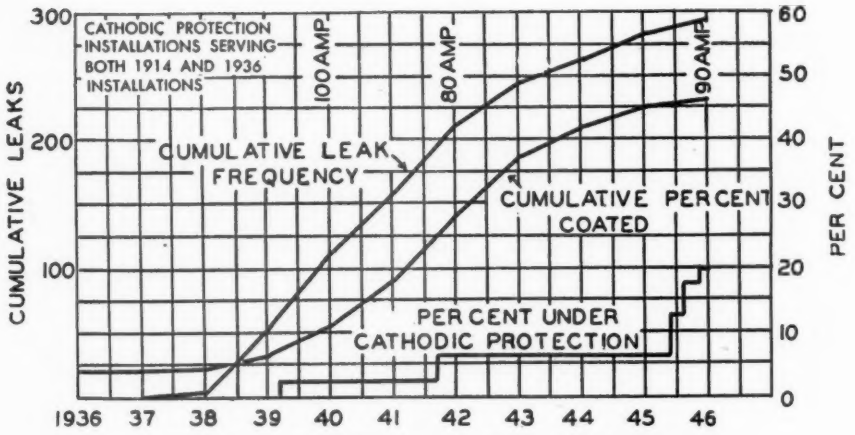


FIG. 2. Coalinga-Martinez 8, 10, and 12-in. pipe line constructed in 1936. Total length 170 miles.

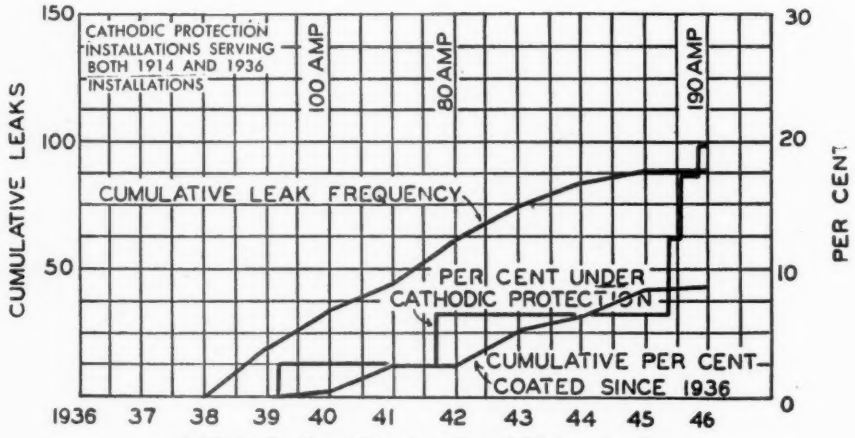


FIG. 3. Coalinga-Martinez 8 and 10-in. pipe line constructed 1914-15. Total length 170 miles.

4. Corrosion has been accelerated by the higher operating temperatures of the pipe line, which have been in the range of 170 F to 200 F, whereas prior to 1936 they were about 140 F.

It has been found that, without adequate cathodic protection, leaks will begin to occur after about five years' service in pipe coated with the coal tar or asphalt enamel and wrap when operating under the line temperature and soil conditions that have existed between Bakersfield and Coalinga. Cathodic protection has been added from time to time to increase the coverage and current density.

In conclusion, some of the money is still unexpended that would have been required to coat all pipe laid in the 1936 program despite the foregoing conditions that increased the reconditioning costs; however, of the pipe laid without coating in 1936, 67 per cent still remains uncoated and a small amount of reconditioning has been necessary on pipe that was coated in 1936. Furthermore, if there is a limit to the life of a protective coating supplemented by adequate cathodic protection, the coatings applied in 1936 will require attention long before the coatings most recently applied.

There is one disadvantage to the procedure to which attention might be called. More leaks have occurred with uncoated pipe than would have occurred had the pipe been coated, and leaks seem to occur at the most unusual times and have no respect for nights, holidays, or weather, so that there has been considerable inconvenience to the maintenance forces. ★ ★ ★

The metal may not be defective

HAVE you ever been nonplussed over the snapping of a swing joint or an expansion joint? Probably you said, after the breaking, "I simply can't understand it. All I did was to turn on the steam—and—it broke. The steam didn't even get up to full pressure. The metal must have been defective."

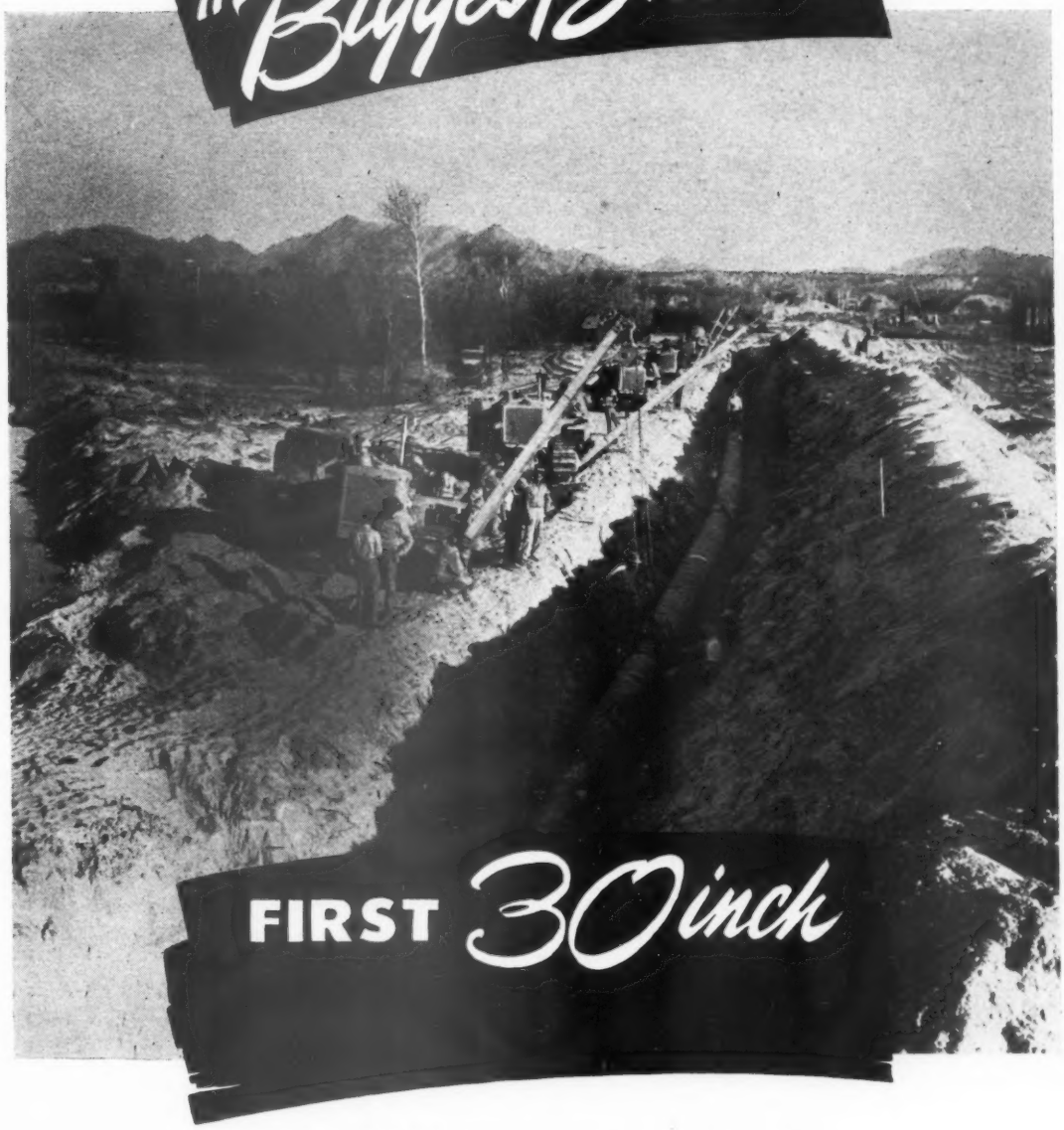
Yes, such ruptures have happened to many a swing joint and expansion joint because of the "suddenness" with which the steam was turned on. The thing to do is to turn the steam on gradually so that no excessive stresses or strains will be set up within the metal. By turning the steam on suddenly the inside of the metal is heated quickly—before the outside can heat and expand along with the inside. Terrific forces are set in this way and the only thing the outer layer of metal can do is to "let go"—and it does let go. This applies to low pressure steam as well as to high pressure steam because the temperature of steam is never lower than 212 F. Water seldom creates this havoc in piping because the first water that passes through a pipe is always fairly cool, consequently the suddenness of heating does not take place.

Inversely the same result often follows from the sudden cooling of metal. Thus in tempering tool steel many a piece of valuable steel has been cracked and ruined by improper handling. Heat an ordinary piece of glass, for example, and drop cold water on it. Almost invariably, the glass will break. ★ ★ ★

H.C. PRICE CO.

GENERAL PIPE LINE CONSTRUCTORS

"Biggest Inch"



H. C. PRICE CO. is now constructing the 30-inch section of this Texas-California project from the Arizona line to Los Angeles.

H.C. PRICE CO.

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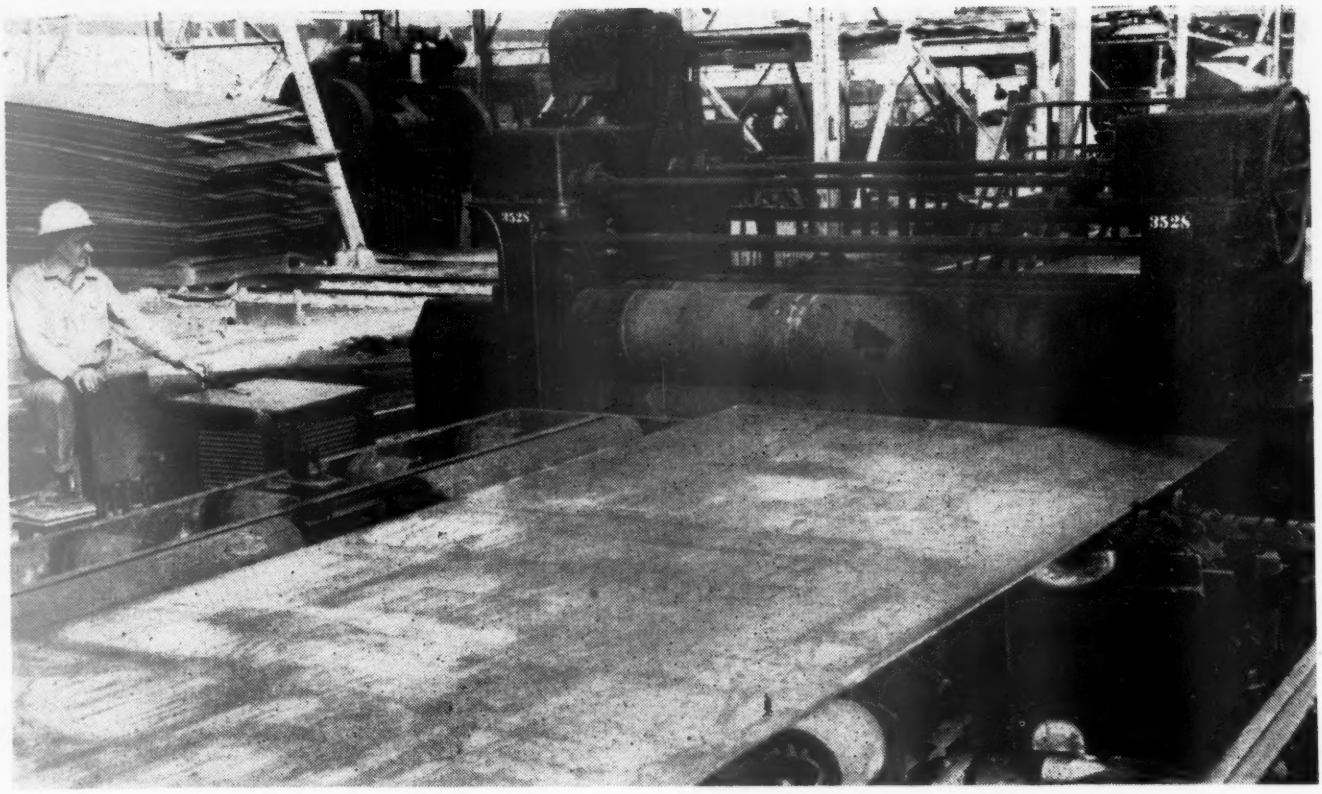


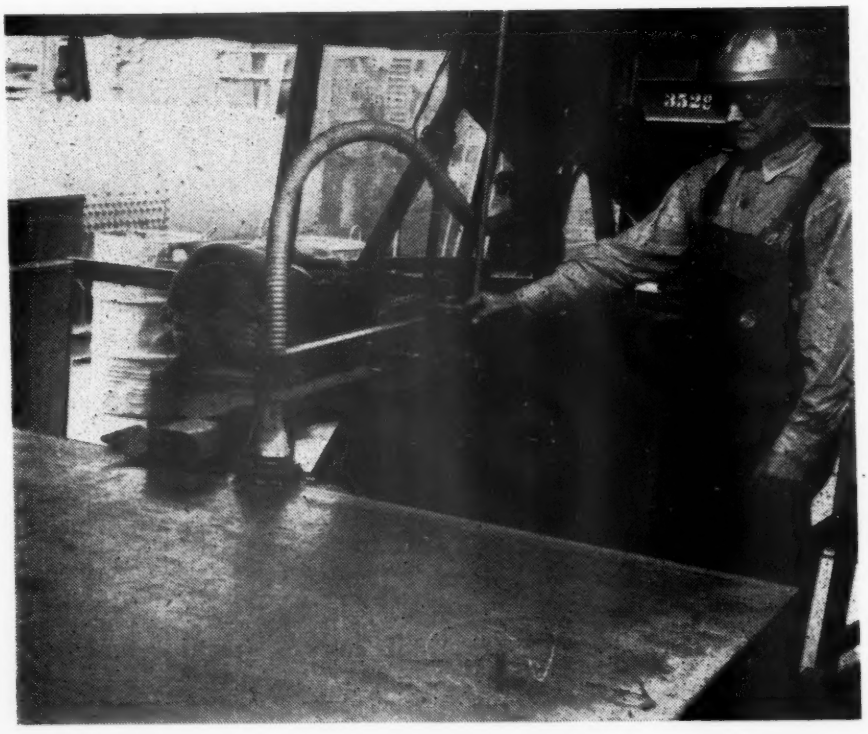
Ultra-modern fabrication for Biggest Inch

By **RICHARD SNEDDON,** *Pacific Coast Editor*

EXCLUSIVE

BY THE time H. C. Price Company had been awarded the contract for laying the last link of the 1212-mile natural gasoline line from Dumas, Texas, to metropolitan Los Angeles—that is, the California section, from Blythe to Santa Fe Springs—a process had been perfected, and work was already well advanced on the fabrication of the high-test 30-in. pipe that was to be used on this part of the line. Indeed, as fast as the big "cans" rolled over the fence at the Maywood plant of Consolidated Steel Corporation, they were being hauled out and strung along the proposed route, and as this is being written, with the scheduled starting date for line laying still two weeks away, 45 miles of pipe has already been strung along the right-of-way.

Varying in wall thickness from 9/32



Above, flat plate approaching leveling rolls. Right, grit-blasting both edges of plate to insure clean surfaces for welding.

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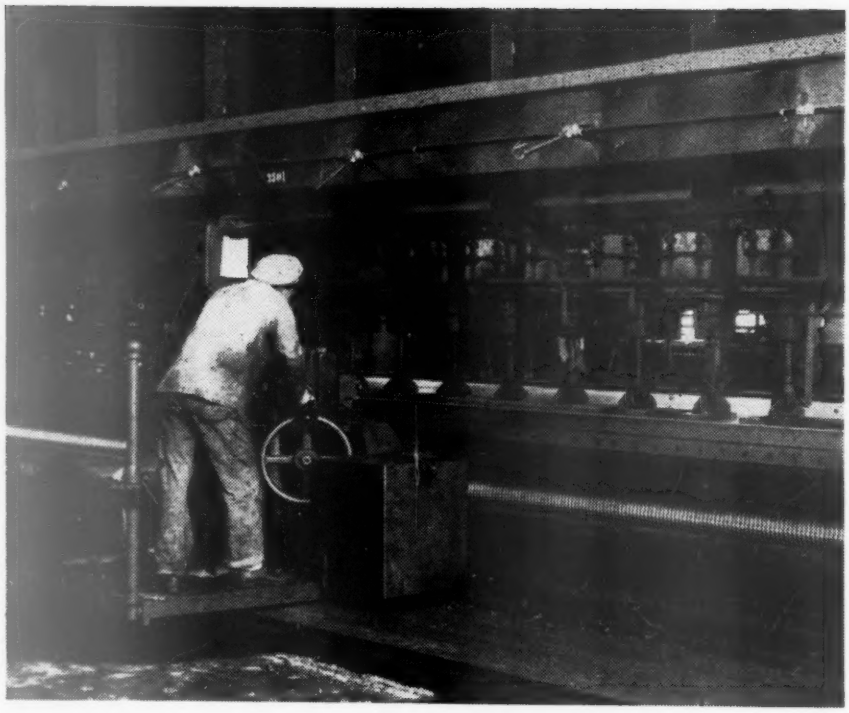
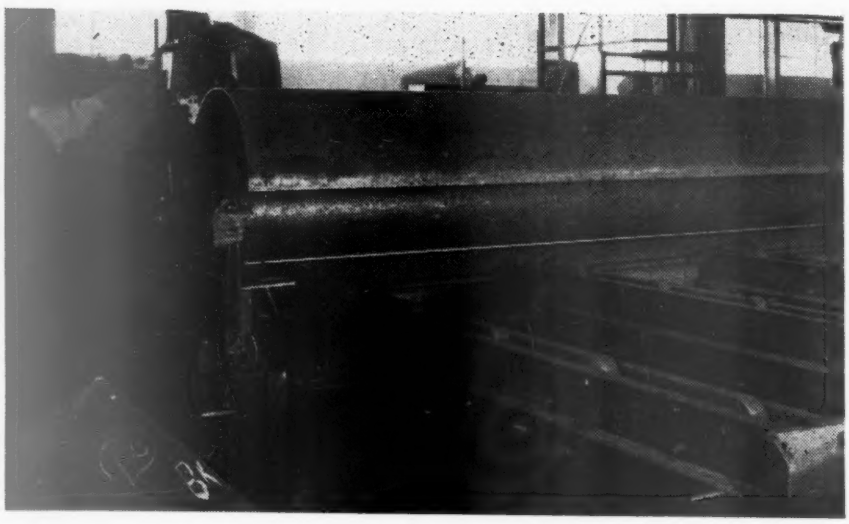


Planing edges of flat plate to true size and proper bevel.



Thirty-foot plate being rolled into cylinder on pyramid roll.

in. to ½ in., the pipe, including the seam, has the following specified minimum transverse strengths: Yield, 52,000 psi; ultimate, 72,000 psi. Its method of fabrication has already been described in brief by A. F. Bridge in his article, "Texas Gas for California," which appeared in the November and December numbers of *The Petroleum Engineer*, but it incorporates several somewhat revolutionary departures from normal procedure that are worthy of further exposition.

It should be pointed out first, perhaps, that there was no possibility of adapting available machinery or equipment to this need. It necessitated the design of supplemental and highly specialized tools. The entire process was worked out from scratch "on the board" by Consolidated engineers, and the facilities finally determined upon were promptly installed at a cost approximating one million dollars. It took about six months to build the pipe plant. Despite its magnitude, however, and the immediate and prospective purpose to which it is being applied, it is in reality more or less of a side issue so far as company operations are concerned.

The process is quite simple but embodies several steps, such as continuous welding of the longitudinal seams by means of a submerged arc, and hydraulic expansion and testing of the welded sections, which are particularly interesting. The beginning material consists of special manganese steel plates, approximately 92 in. wide and 30 ft long. They are first passed on a conveyor through the leveling rolls to remove waves or buckles, and thence to a shear, which trims the ends square and to proper length. Next they are vacu-blasted with steel grit to clear the longitudinal edges of scale or extraneous matter that might later interfere with the welding. These same edges are then trimmed to size by the planers, which reduce the plates to exact width and squareness, and at the same time give the edges their final clean-off for welding.

Then follows the shaping process, in which the sheets are first fed to an edge roll that conforms them to the proper curvature at the edges, so that when they are later fed to the pyramid rolls they take a completely cylindrical shape. They are now ready for welding, and each tube is provided with a starter plate that projects a few inches beyond the periphery of the pipe. When the pipe goes through the welding machine, the initial stretch of seam is on this starting plate, and the likelihood of any imperfection on the pipe itself at the starting point is thus avoided.

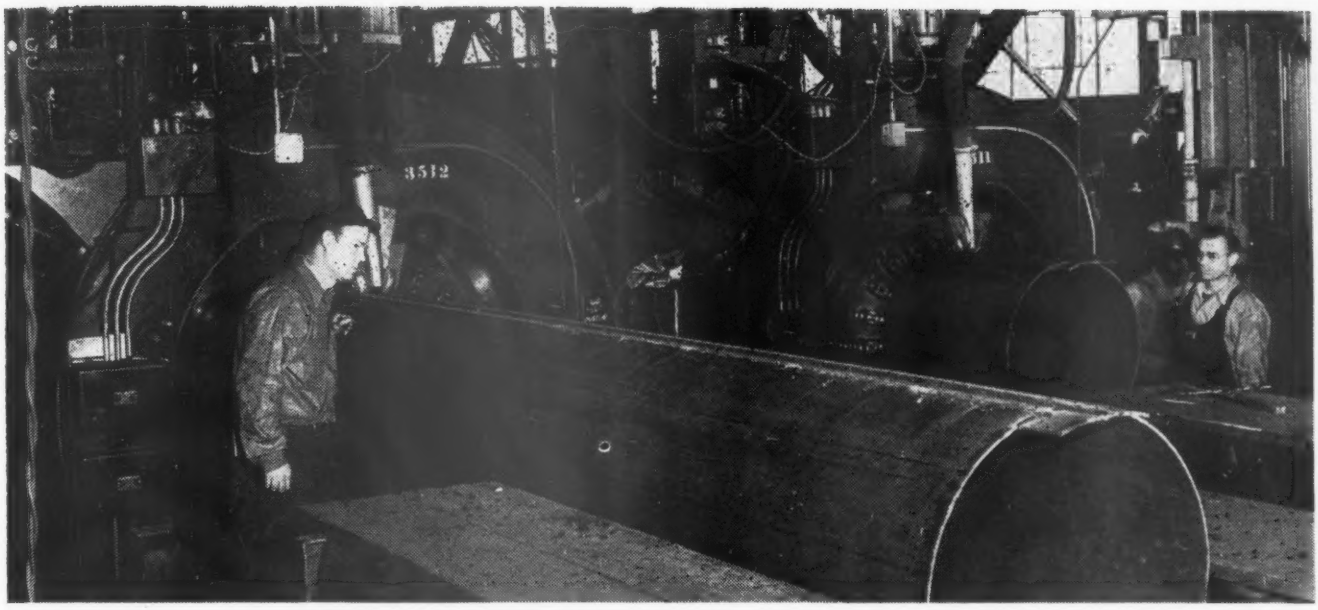
The submerged arc process is free from the pyrotechnics that usually accompany a welding operation. The pipe passes fairly rapidly through the welding machine with the abutting edges in proper relationship. The seam is completed without visible evidence of the great heat that is engendered by the passing of a heavy current from a submerged electrode through the granular metal that lies between the two edges and comprises the "melt." When the seam has been completed, the starting plate is cut off, and the cylinders are then conveyed to the end stretchers. It might be noted in the meantime, that the finished weld is without the irregularities or the characteristic wavy effect of a manual weld, is very uniform, and of good thickness and penetration.

The function of the end stretcher is

Pipe line commission

An Oil Pipe Line Study Commission has been authorized by the President of the Republic of Brazil. It is to be named by and be responsible to the president of the National Petroleum Council.

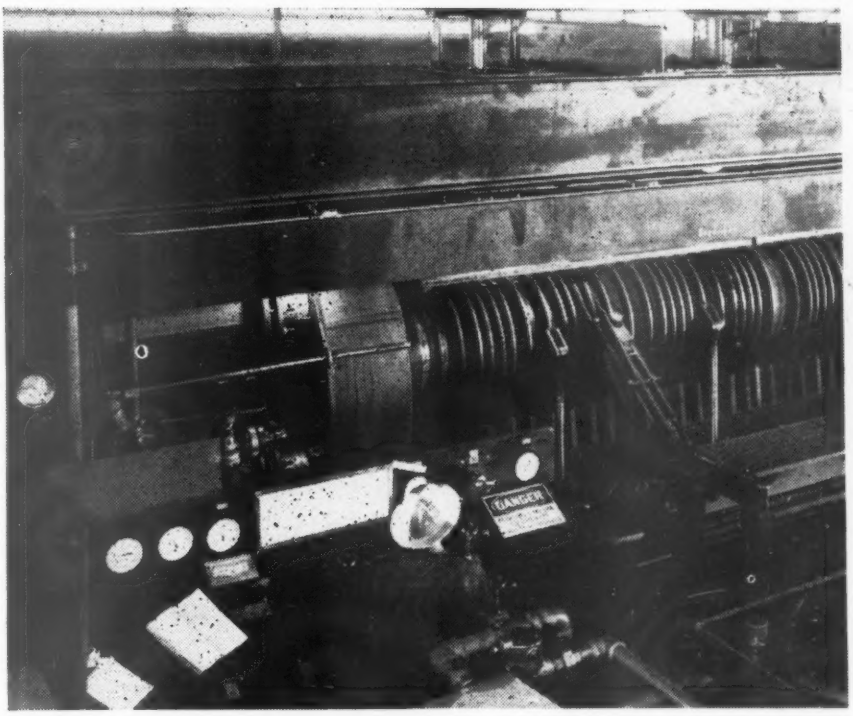
The Commission is in charge of studying pipe line transportation from the Port of Santos to the City of Sao Paulo; of proposing pipe lines; of indicating the route, general conditions of construction, proper type of installation, and probable cost; and of drawing up rules governing submission of bids for construction and operation of the oil pipe lines. The chief purpose of this projected system is to provide transportation of crude oil to refineries.—From *Brazil Trade Journal*.



Machines welding longitudinal seams by submerged arc process.

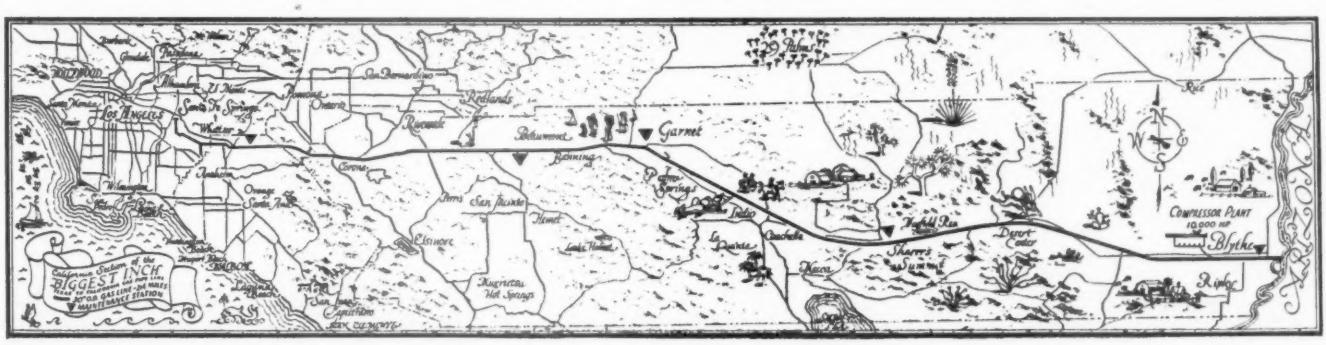
to expand the ends of the pipe to its full 30-in. diameter so that it can be mounted on the hydraulic expander, where the remainder of its length is similarly enlarged. Surplus stretch is obviated by a surrounding die that holds the pipe to the specified diameter, while water pressure brings it up to size. When fully expanded, the pressure is reduced to test level, the weld being hammer tested and examined for leaks at this stage. The ends are thereafter faced and beveled for welding and each pair of 30-ft pipes are welded together circumferentially to make up into 60-ft sections for shipping. A submerged arc is also used in this operation.

After final inspection, the sections are transferred by conveyor to adjacent property, where they are blasted, primed, coated with coal tar, and wrapped with asbestos felt. Trucks and trailers, carrying six sections to the load in padded cradles, haul the pipe to the line. Throughout the process, from the making of the steel at the mills to the shipment of the pipe, careful records, tests, and checks are made to insure the qual-

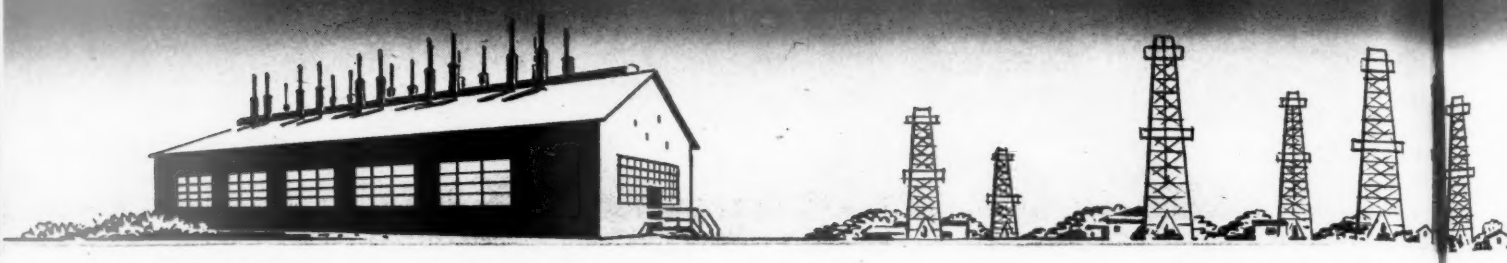


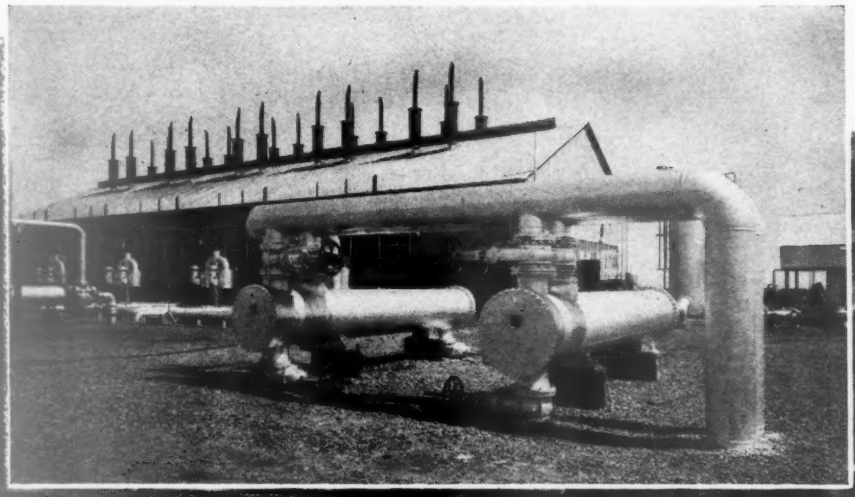
Hydraulic expander in which all the pipe sections are stretched and tested.

A map of the California section of the Biggest Inch, a 30-in. gas pipe line being laid from West Texas to California.



JUST WEST OF





Exterior view of compressor house at the McC
gasoline absorption plant. After natural gasoli
extracted, residue gas is furnished to nearby
panies. (Photographed by Elwood M. Payne, Hou

Ten 8 cylinder (800 BHP) Clark Right Angle Gas-Engine-Driven Compressors give reliable operation at the McCarthy Oil and Gas Corporation gasoline absorption plant at Winnie, Texas.

BEAUMONT, TEXAS...

Just 25 miles southwest of Beaumont, Texas, is the gasoline absorption plant of the McCarthy Oil and Gas Corporation. Here natural gas is gathered from the field, compressed and then put through an absorption plant where the natural gasoline is extracted. In this plant ten 8-cylinder (800 BHP) Clark Right Angle Gas-Engine-Driven Compressors are equipped with the proper compressor cylinders to give three stages of compression.

McCarthy Oil and Gas Corporation selected these Clark units for their absorption plant at Winnie, Texas, after a thorough field investigation to determine the unit that was most applicable to their particular problem, especially in relation to:

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3. Low operating cost, and 4. Low maintenance cost.

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ity and the uniformity of the product. The scheduled production rate at the Maywood plant is 9 miles a week, or about one 30-in. section every 4¼ minutes.

The 30-in. pipe will be installed from Santa Fe Springs to Blythe, as already intimated, and is that portion of the line—214 miles in length—being constructed by the Southern California Gas Company and the Southern Counties Gas Company, of California. Actual work on the construction of the line was scheduled to start on February 3 but a large percentage of the pipe was strung before that date. It is believed that this particular section of the line will be larger in diameter than any high pressure transmission line that has ever been built.

In general orthodox methods of pipe line installation are being used, but because of the unusual size and weight of the line, the heaviest of construction equipment is being employed. Prior to hauling and stringing, light grading is being done along the right-of-way to make it negotiable by trucks and tractors hauling pipe. RD-8 Cats equipped with bulldozers are being used for this purpose and RD-8 Cats equipped with side arms are also being used to unload the trucks that haul pipe from the plant to the job.

Before actual pipe laying begins, the final grading of the right-of-way is completed. This grading in rough country is expected to involve the movement of large quantities of dirt, because a traveled right-of-way, wide enough to accommodate a trenching machine and still leave room for other construction machinery to operate, must be graded. This right-ofway is being graded in such a manner as to avoid angles and turns as far as possible. RD-8 Cats with bulldozer attached are again used for this purpose.

After the right-of-way is thus prepared, the trench is then dug. For pipe of this diameter and heavy weight, the largest available trenchers must be used. These are capable of digging a trench 42 in. in width and 8 ft deep. In general, however, a trench 5 ft in depth will be dug, which will provide a 2½ ft covering, but in cultivated areas the line may be laid at an approximate depth to protect it against possible washouts. For welding pipe in the field, the electric process with shielded arc is being used. This process develops the full strength of the pipe and assures perfect welds.

Although this is the biggest high pressure transmission line yet to be built, no insurmountable difficulties are an-

Top, squaring ends of pipe and machining bevel for welding. Left, welding circumferential seams by submerged arc process.

Specify Gar Wood!

Maybe it isn't a pretty *word*... but it's a *mighty* beautiful sight to watch those good Gar Wood Winches hauling and lifting and skidding 40-ton loads around as easily as only they can.

It's a fact! Where the going is roughest, where the job is toughest... *that's* where Gar Wood Winches *really* prove themselves... every time! For they're designed, engineered, and built for *dependable*, extra power... with plenty of muscle, plenty of *guts*... literally *built to take a beating!*

If an "impossible", extra-tough job has *you* down, take a look at the new Gar Wood 7MBD (illustrated)... the biggest, toughest truck winch in the world. 4¼" drumshaft, 75,000 lb. rope pull... handles almost any load ... easily, safely, and *fast*. Full cab control of jaw clutch and brake, brake band on drum flange, automatic safety brake on worm shaft. And power ... *guts* to spare! .... *For your own good... specify Gar Wood!*

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Brush-cleaning inside of the pipe sections.

Checking wrapped pipe with holiday detector.

Unloading pipe from one of the trucks that string it along the pipe line route.

ticipated. Routine pipe line construction methods are being employed and all the usual precautions are being observed with an extra precautionary measure here and there to assure the ultimate success of the project. For example, 10 per cent of all welds will be tested by the X-ray method, which is the equivalent of one weld per day per welder. This has never been done on a gas transmission line before, but in view of the success of X-ray testing in shipyards during the war, it is felt that the device will give an added measure of protection that should well justify the time and expense of the effort.

Sections of weld ells will be used for making angles in the field, which is a departure from the usual pipe line practice, since it has been customary to make them by what is known as the "wrinkle" process. It is believed that sections of weld ells will result in a more satisfactory job.

In conclusion, a few statistics may be of interest: The weight of the steel in the 214 miles that constitute the California section of the line is approximately 60,000 tons. The ultimate capacity of the line is 305,000,000 cu ft a day. The approximate weight of this quantity of natural gas is 7625 tons. In 10 days operation at capacity, the line will have carried a quantity of gas more than the equivalent in weight of the 214 miles of pipe and all the valves that will go with it.

★ ★ ★

Pipe Line
P 629.

A study of the clarification of
Compressor station recycle cooling water

By **E. G. HAMMERSCHMIDT,** *Chief Chemist,* Texoma Natural Gas Company

TEXOMA Natural Gas Company's compressor station No. 21, at Fritch, Texas, uses the open type recycle cooling water circuit, i. e., the warm water from the outlet of the compressor jackets is pumped over an atmospheric type cooling tower; the cooled water falls over the compressed gas aftercooler coils at the base of the tower, and thence it is recycled through the engine jackets. This cycle is not uncommon in commercial application. Recycle cooling system water at Station No. 21 was used to obtain all the experimental data in this study and this water is hereinafter designated "system water."

EXCLUSIVE

● **Advantages of filtration.** The suspended matter in system water consists of a major quantity of oil together with smaller amounts of silica, calcium, and magnesium carbonates, iron compounds, and organic matter. In time, this finely divided matter coalesces and settles within the engine jackets, cooling tower basin, hot well, and the 100,000-gal storage reservoir. A film of sludge on the engine jackets acts as an insulator and results in poor and unequal heat transfer between the hot jackets and the cooling water. If the debris settles so that a portion of the jacket walls remains uncovered, it may cause localized pitting of the metal. Various kinds of sludge deposits are believed to be capable of producing this localized attack and oil is often cited as an offender, as when a drop of inert oil rests against a metal surface that is immersed in salt water. On the other hand, oil emulsions are sometimes added to cooling waters, forming a milky liquid that produces much less corrosion than untreated water.

In the early days of operation, system water was extremely turbid (about 2000 ppm) and there is little doubt that the suspended matter in the water at that time caused some erosion on pumps and equipment. This effect has probably been reduced by present day operations in which the normal blow-down schedule maintains a turbidity of system water in the region of 100 ppm.

Algae and slime growths are more prolific at Station No. 21 than at any other location within the system. A number of algaecides have been tested but the only one that has given positive results is chlorine. Considerable quantities of chlorine are required to control the algae-slime conditions, and the corrosiveness of system water is increased to some extent by use of chlorine gas.[2]

The above description of conditions at Station No. 21 is suggestive that several advantages would accrue if all suspended matter in system water were removed by filtration. Elimination of sludge in engine jackets would improve heat transfer, which in turn would decrease overall engine wear. It would also mitigate localized corrosion in engine jackets. It would save the labor required to manually wash out engine jackets. Filtration will remove most of the organisms in system water and thus the amount of chlorination would be drastically reduced or eliminated entirely, for there is a distinct probability that filtration might permit the replacement of chlorine treatment by a less frequent "shock" treatment, using an algacide that is not corrosive to ferrous metals. The use of alum as a coagulant for system water reduces both the alkalinity and the pH of the clarified water. This effect will permit a greater concentration of system water and hence less blow-down wastage.

● **Coagulants.** The overall advantages of using a clarified system water warranted a study of methods for attaining this objective. The suspended matter in system water is so finely divided that it cannot be strained out by means of a sand bed alone. In fact, a considerable portion is so fine that it will pass through filter paper. For this reason it is necessary to use certain chemicals to aid in the filtration through sand filters. Such chemicals are called coagulants, and their action is to clump together the suspended particles into masses of coagulated matter. Not only is the suspended matter brought into a condition more suitable for filtration, but much of the coagulated matter can be settled out in reservoirs with detention periods of two to eight hours. It is possible to filter out a fairly high coagulated turbidity and produce perfectly clear water, but usually it is economical to provide a long enough sedimentation period for the coagulated turbidity to be reduced to about 5 to 15 ppm before the water goes to the filter.

The factors that influence the coagulation of turbid waters are: (1) Kind of coagulant, (2) quantity of coagulant used, (3) amount and character of suspended matter, (4) temperature, (5) hydrogen ion concentration of the water, and (6) time of mixing and violence of agitation.[1]

Some coagulation occurs in system water without the addition of any coagulant. This action is promoted by the aerating effect in the cooling tower. For example, it is known that the turbidity of Station No. 10 system water diminished after the installation of the gasification tower, which brings the system water into contact with tiny gas bubbles.[3] In like manner, laboratory tests on aeration and gasification of stations No. 21 and No. 2 system waters produced 16 per cent more clarification when air or natural gas was first bubbled through than when plain sedimentation occurred in an equivalent time interval.

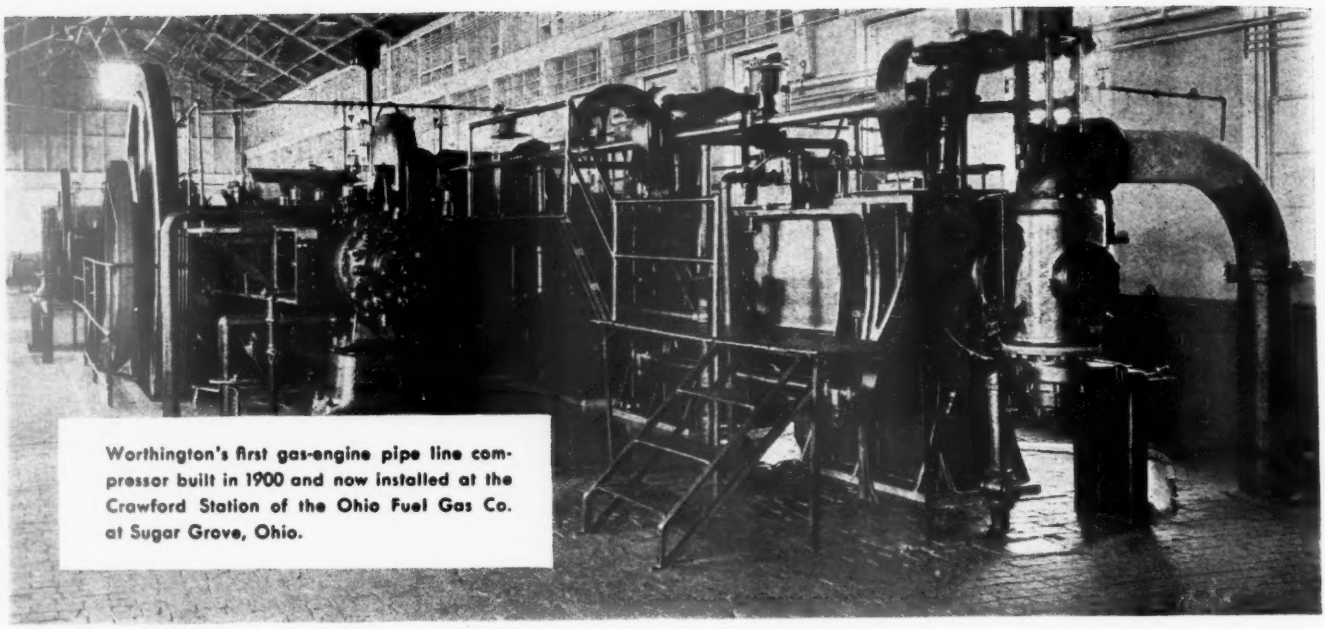
Several coagulants have been tested with system water, e. g., aluminum sulphate, ferric sulphate, ferrous sulphate, and sodium aluminate. Better results were obtained with aluminum sulphate and ferric sulphate than the latter two chemicals. As alum is cheaper and easier to handle (less corrosive) than ferric sulphate, the former was chosen as the coagulant to be used in all subsequent laboratory and pilot plant tests.

There is a certain amount of coagulent that will coagulate the water to the extent that when filtered through sand filters, all the turbidity will be removed. This amount varies greatly and can be determined only by trial, although there is some relation between the turbidity and the amount necessary to use. This amount was determined from a sample of system water in which the original turbidity was 130 ppm. Lower turbidities were obtained by dilution with distilled water. The following alum requirements were shown:

Turbidity, ppm	Alum required, ppm
130	100
100	72
80	53
60	36
40	19
30	12

The addition of an excess of the coagulant over the minimum required will hasten the formation of the floc and will increase the bacterial efficiency slightly. Temperature has considerable influence on the rate at which coagulation takes place, but has little influence on the quantity of coagulant necessary to use. Alum will usually give good coagulation with the pH range 5.5 to 8.0[1]. The latter value is the approximate pH of system water.

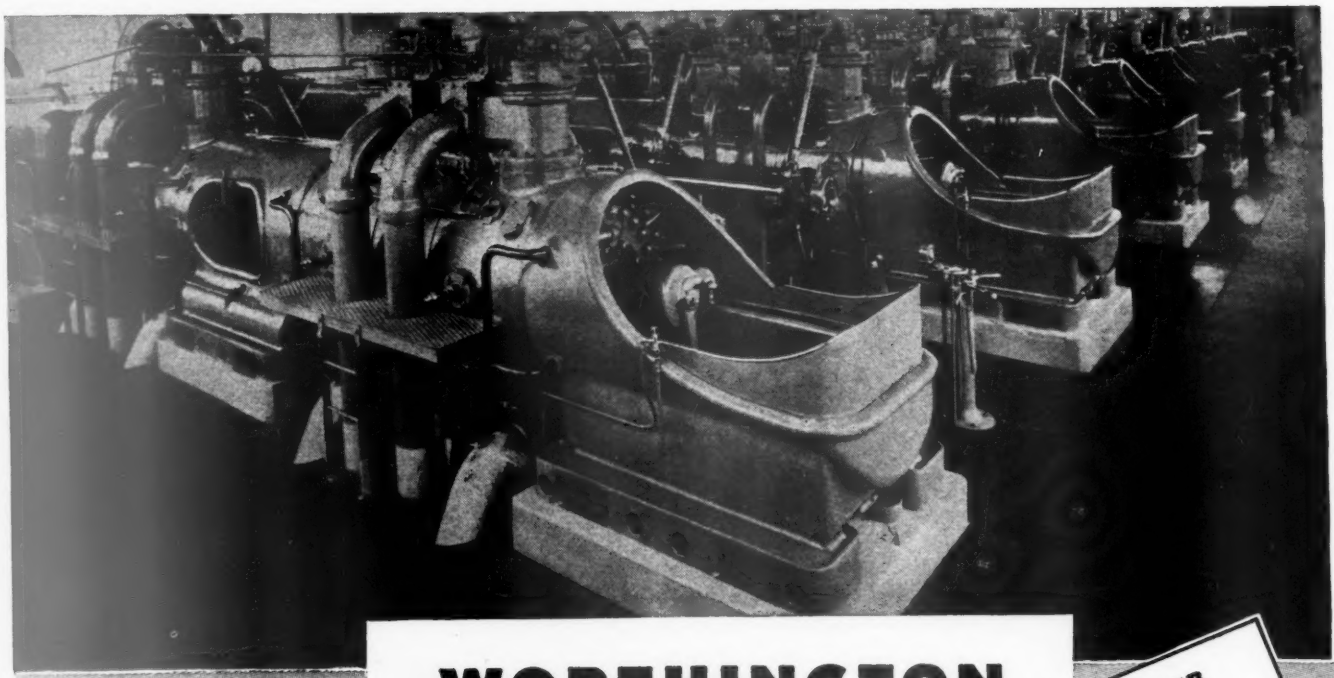
● **Sedimentation tests and sludge blanket conditioning.** A jar test was made in the laboratory during a six-week period in which system water and alum were continuously added to the



Worthington's first gas-engine pipe line compressor built in 1900 and now installed at the Crawford Station of the Ohio Fuel Gas Co. at Sugar Grove, Ohio.

WORTHINGTON'S

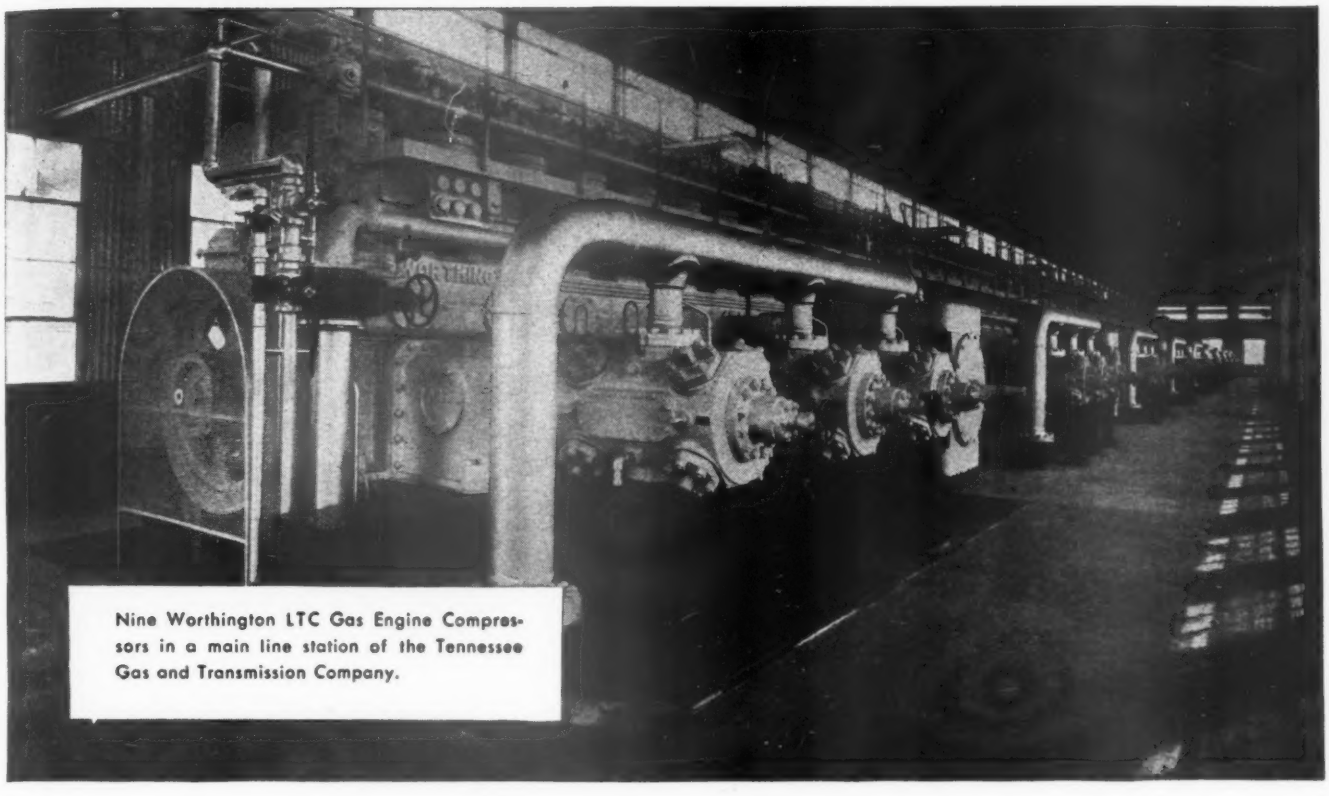
45-year pipe line history assures



Worthington horizontal gas engine installation on the Northern Natural Gas Pipe Line.

WORTHINGTON

YOUR PARTNER IN POWER PROGRESS



Nine Worthington LTC Gas Engine Compressors in a main line station of the Tennessee Gas and Transmission Company.

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In 1900, the first Worthington gas-engine pipe line compressor "went on the line." An 800 horsepower horizontal unit delivering ten million cubic feet of gas per day . . . it is still in excellent shape and in constant service.

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Worthington now offers several designs of gas engine compressor units together with a full line of Worthington auxiliary equipment. That's why a modern pipe line station can now be truly 100% Worthington powered . . . with all the advantages such unit responsibility offers.

Worthington is exceptionally well staffed with engineers experienced in selecting and designing all power equipment for pipe line stations . . . another reason why *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Harrison, N.J.*

ES-2

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. . . gas engines, 175 to 3,500 hp.
. . . dual-fuel engines, 150 to 3,290 hp.

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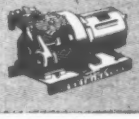
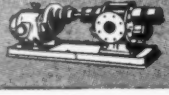
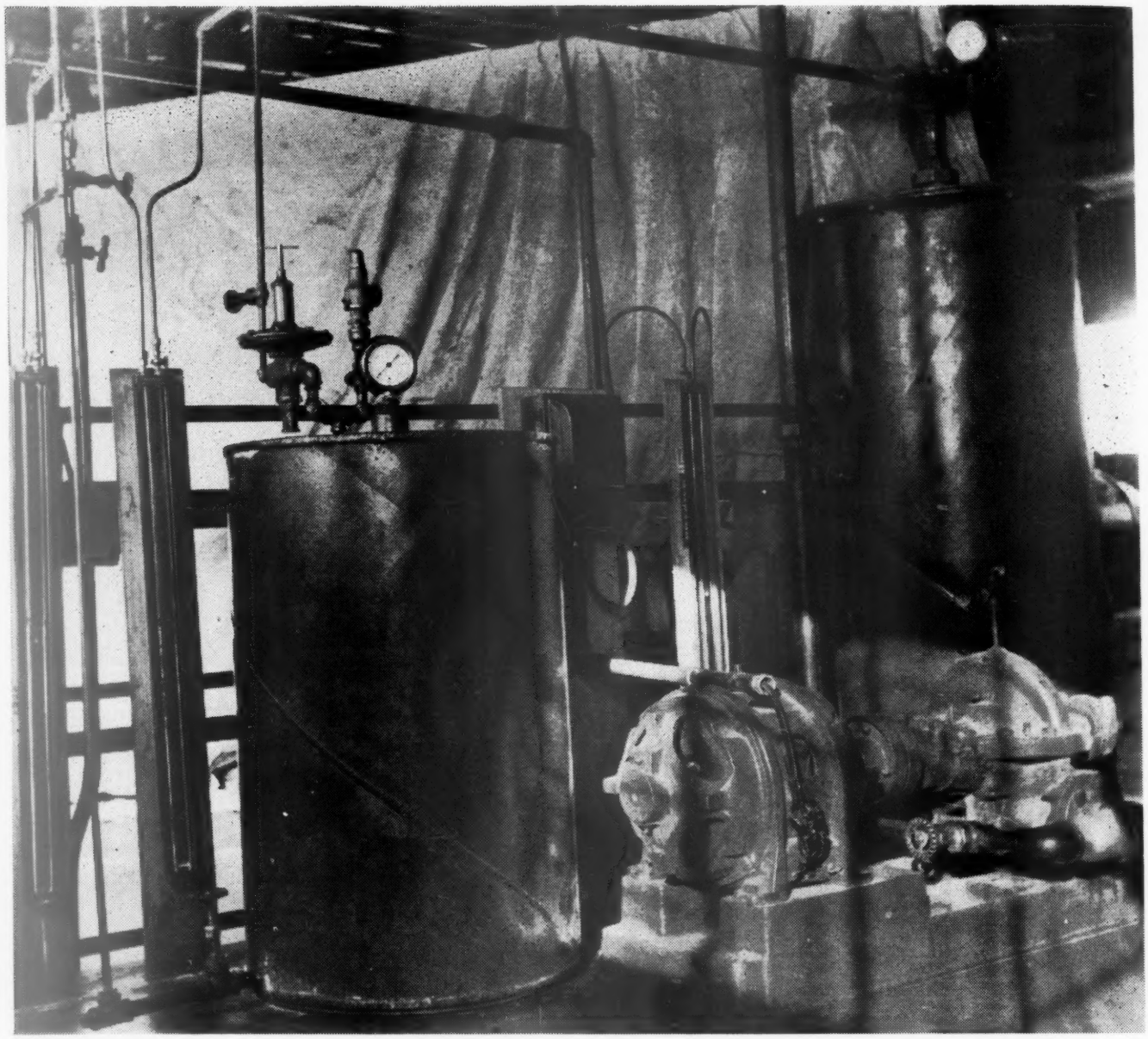


Oil Transfer Pumps



Cooling Water Circulating Pumps

Evaporative Type Engine Water Cooler



Pilot plant pressure filter apparatus showing the porous plate pressure filter tank at the right, alum feed tank at the left, and circulating pump in right foreground. The three manometers measure the pressure drop across calibrated orifices (reading from left to right) in alum feed, inlet water, and back-wash lines.

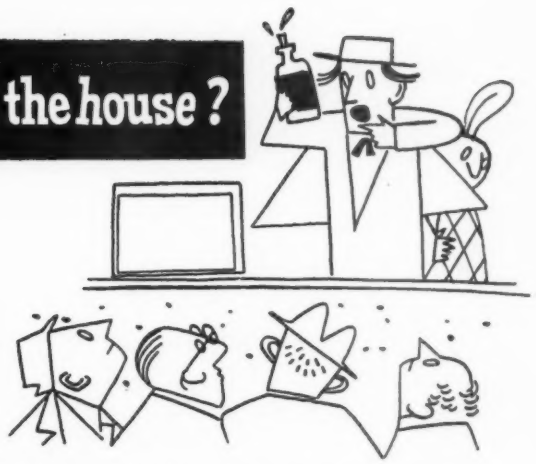
bottom of the jar and withdrawn from the top until a sludge blanket had formed in the lower part of the jar. Under optimum conditions the effluent water was clarified to a minimum turbidity of 17 ppm. Best results were obtained when the sludge blanket was continuously but gently mixed. The sludge blanket was easily upset when the flow rate was suddenly increased or if any air bubbles entered the feed line. In either case the upper layer of clarified water became turbid almost at once.

A pilot plant model was next built for additional sludge blanket tests. A tank made from a 10-ft section of 24-in. pipe was set in vertical position. Inlet system water and alum were introduced at the bottom of the tank. It was necessary to provide an air trap to remove entrained gases from the inlet water before it entered the tank. The pilot plant was operated for a period of six weeks during which time various rates of flow, retention times, and alum feeds were tested. The sludge blanket was built up to a depth of 48 in. Good coagulation was obtained on passage through the sludge blanket but there was always some of the lighter floc that would not settle and it carried over into the effluent line. At times nearly clear effluent was produced but it could not be maintained consistently, varying from 7 ppm to 50 ppm and sometimes greater. Best results were obtained with retention periods of six hours or more. The residual turbidity in the effluent was well coagulated and it could be entirely removed by sand filtration, a condition that is not true in the case of untreated (i.e. uncoagulated) system water.

● **Filters and filtering.** "Rapid sand filters" are units operated at high rates of filtration (2 to 3 gal per sq ft per min) and depend upon the use of a coagulant to aid in the removal of suspended solids. The water passes through the bed of sand by gravity and the filter bed is cleaned by back-washing. "Pressure filters" are constructed similar to rapid sand filters except the filter is usually placed in a cylindrical tank and the water is passed through the filter under pressure. Filters of this type are intended for use where the water is supplied under pressure and where there is a desire to filter and deliver the water without the necessity of further pumping. The effectiveness of treatment in pressure filters is of necessity very low, as there is no provision for the extensive preliminary processes of coagulation and sedimentation so essential to the satisfactory operation of a rapid sand filter installation.

Is there a DOCTOR in the house?

If there is, and it happens to be this guy—well, you can move. (Or *can* you?) . . .



This "doctor" seldom worked in the house, preferring the open air—and a clear avenue of escape . . .

Tree surgeons, however efficient and conservative they may be—are frequently "out on a limb," although seldom stumped . . .

M.D., H.V. (Movie doctor, Hollywood version). Seldom where they should be—are practically always "wanted in surgery," and just as frequently are just wanted. All are specialists in psychoanalysis . . .

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88
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● **Porous plate underdrains.** In the past, conventional filters have been equipped with graded gravel beds and lateral drains. A more recent type of underdrain system was placed in commercial use about ten years ago. This is a porous plate underdrain that eliminates the graded gravel bed and lateral drainage system. These porous plates are manufactured by the Carborundum Company and by The Norton Company. Some of the advantages that have been claimed for the porous plate underdrain are as follows: Back-washing of filter media is positive and uniform; uniform suspension of the entire filter bed during bask-washing is inherent, for the entire filter bottom is covered with porous plates beneath which a uniform water pressure exists; satisfactory washing of every portion of the filter eliminates objectionable mud balls; good washing also reduces the total quantity of wash water required. In the older conventional underdrain systems a really uniform back-wash maintains graded gravel and sand in equilibrium, i.e., with the finest material on top. If there is any irregularity of washing, however, sand is often lost by washing out over the wash troughs or leakage through the graded gravel and underdrainage system. If the back-wash becomes very non-uniform the graded material may be entirely disrupted and mixed. The net result is not only loss of sand and general inefficiency, but the necessity of careful regrading of the gravel bed at heavy expense. With porous plate underdrainage, it is impossible to lose sand. Even if backwashing were non-uniform the filter could not be upset, as only one grade of filter media is used, and lateral movement will cause no trouble. This particular benefit is outstanding in connection with zeolites for softening, because of the high relative value of such materials[5].

● **Filter media.** In view of the above claimed advantages of a porous plate filter, it was decided to construct a pilot plant filter to obtain some operating data on station No. 21 system water. A circular porous plate was purchased from the Carborundum Company and fitted into a section of 24-in. pipe. Sand was screened and graded to obtain an approved grade of filter-sand that had the following characteristics:

Retained on 20-mesh sieve, per cent	21.1
Retained on 40-mesh sieve, per cent	78.4
Fines, per cent	0.5
Total	100.0
Effective size	0.50
Uniformity coefficient	1.46
Soluble in hot concentrated HCl, per cent	9.3

Effective size is that diameter of sand in millimeters below which 10 per cent of the sample is finer and 90 per cent of the sand is larger. Uniformity coefficient is the ratio between the size in millimeters such that 60 per cent of the sand is finer than it and the effective size.

The depth of the sand in the filter was 24 in. during most of the runs and sufficient space was allowed above the sand bed so that a retention time of six minutes was allowed before the alum-water mixture reached the filter bed when flowing at the rate of 3 gpm per sq ft of filter area. Some typical data obtained from this filter are shown in Table 1.

● **Determining alum dosage.** Excellent correlation was obtained between the actual turbidity of the effluent from the pilot plant sand filter and the laboratory stirring machine test[4] when using an inlet sample of the alum-water mixture to the sand filter. Hence the laboratory method is a rapid and reliable means for determining the correct alum dosage for a commercial installation.

● **Back-wash rates.** The rate of application of backwash water necessary to give satisfactory results depends primarily on the character of the water to be treated and the size of the sand grains. Until recently washing rates ranging from 12 to 14 in. up to 24 in. vertical rise per minute were considered ample, with a tendency toward higher rates. Present indications in modern sand filters are that application of water at a rate to give approximately 50 per cent expansion of sand during washing produces the most effective wash. With

TABLE 1. Porous plate filter runs.

Run no.	Alum feed, ppm	Filter rate, gpm per sq ft	B.W. rate, vertical rise per min.	Filter inlet, turbidity, ppm	Filter effluent			Pressure drop at end of run, psi	Length of run, hr.
					Turbidity	Alkalinity	pH		
2 (a)	40	1.4	15	108	30	115		13	28.5
3	50	1.4	16	108	30	116		7	18.0
4	60	1.4	15	108	14	116		15	25.7
5	65	1.4	15	108	0	108		17	22.5
6	65	3.0	13	108	0	108	7.5	14	9.7
7	65	3.0	13	108	4	112		12	6.8
9 (b)	65	3.0	5	108	0	145		11	12.0
9 (c)			15						
10 (d)	65	2.2	16	0	0			6	21.0
11 (e)	65	3.0	16	108	0			9	7.3
12 (f)	65	3.0	16	108	0			20	17.0
34 (g)	100	3.0	24	140	0	58	6.7	20	
36 (h)	100	3.0	24	140	0				9.5

(a) Depth of sand 24-in. in runs 2 to 34. (Back-wash abbr. B.W.).
(b) Air injection during B.W. Filter was not cleansed properly.
(c) Second B.W. with air injection and increasing B.W. rate. Very clean filter.
(d) Zero turbidity inlet water used on this run.
(e) Filter bed was not being cleaned properly during B.W.
(f) Air injection for agitation before B.W. Filter was clean after the B.W.
(g) Filter was very clean after the B.W. (No air injection.).
(h) Removed all but 12-in. of filter sand. Time required for B.W. decreased.

PICTURE QUIZ: Which of these five people gives the right reason for buying U.S. Bonds?

(ANSWER BELOW)

1. Easy to save! "I'm putting my money into U. S. Bonds because it's the *easiest way* for me to save. Under the Payroll Savings Plan, I put aside a regular amount each week for Bonds. So far, I've saved $500 without missing the money!"

2. Good investment! "Getting back $4 for every $3 I invest—the way I will in ten years' time with U. S. Bonds—is my idea of a *good investment*. I know it's safe and sound, too, because it's backed by Uncle Sam. Buy Bonds, I say."

3. Plans for the future! "Ten years from now, the money I'll get for my U.S. Bonds will help to send my kids to college, or buy our family a new home. I think that buying U. S. Bonds is the wisest thing a family man can do."

4. Fights inflation! "I want America to stay economically sound. That's why I'm putting all our extra dollars into U. S. Bonds. It's like buying a share in our country's future prosperity!"

5. Rainy day! "Maybe a rainy day's coming for me. Maybe it isn't. But I am taking no chances. That's why I'm buying all the U. S. Bonds I can through my Payroll Savings Plan."

THE ANSWER

Every one of these people gives the "right" reason—because there's more than one right reason for buying U. S. Bonds.

Whichever way you buy them—through Payroll Savings, or your local bank or post office—U.S. Bonds are the best investment you can make!

Save the easy way..buy your bonds through payroll savings

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the finer sands a rate of 24 in. vertical rise per minute may cause approximately this expansion, but with the coarser sands now in general use, rates as high as 36 in. per min may be required[1].

In the pilot plant filter, back-wash rates from 5 to 16 in. vertical rise per minute did not satisfactorily clean the bed, nor did a supplementary air treatment at the bottom of the filter have any notable effect at these rates. When the back-wash rate was increased to 24 in. vertical rise per minute, the filter received proper cleaning without a supplementary air wash.

● **Depth of filter media.** From experimental data reported in the literature it appears that the penetration of floc and silt into a filter sand varies with the size of the sand used, the temperature of the water, the completeness of flocculation, the quality of the floc, and possibly other factors. Armstrong found that the maximum penetration of silt into a filter was only 6 in. for an average size sand of 0.5 mm, 9 in. for 0.6 mm average size, and 11 in. for a sand as large as 0.75 mm average size. It was therefore deemed advisable to make some tests with a shallower sand bed. All but 12 in. of sand were removed from the filter. Thirteen test runs were completed with the shallow bed and the effluent water was just as clear as with the 24-in. bed. Also, the backwash effluent cleared up in about one-half the time that was required with a 24-in. bed.

The time of mixing the alum feed with the turbid water has an important bearing on the quality of the resultant floc and hence on the effectiveness of filtration. A shallower sand bed would provide additional retention time before filtration, assuming that a filter was built for the deeper bed. Likewise, the porous plate would require less space by an amount that would normally be required for a graded gravel bed and this space could also be used for added retention time with a resultant saving in alum and better conditioning of the floc.

● **Filtering as aid to slime and algae control.** Filtration of system water has distinct possibilities in aiding slime and algae control, as shown by the following laboratory tests that were made during the sludge blanket tests during continuous mixing:

	Organisms per cc	Per cent removal
Inlet system water (100 ppm turbidity)	44,000	0
Effluent sludge blanket, 5 hr detention	26,000	41
Effluent sand filter immediately after passing from sludge blanket	1,500	96.6

● **Amount of filtered water required.** The following calculations indicate that the turbidity of system water can be reduced to 15 ppm by means of a bypass filter that operates at the rate of 294 gpm throughput.

The annual average condition of compressor station system water is as follows:

Turbidity, ppm	100
Daily make up, gal	309,000
Daily evaporation, gal	233,000
Daily blow-down, gal	76,000
Total volume of circulating water within the system, gal	450,000

The stated data show that system water is replaced by clear makeup water about every six days, by means of the blowdown schedule, yet maintaining a turbidity of 100 ppm. Therefore 15 ppm turbidity (i.e. 15 per cent) could be maintained by replacing system water every $6 \times 0.15 = 0.9$ day.

The amount of blowdown occurring in 0.9 day is: $76000 \times 0.9 = 68{,}400$ gal. This amount of blowdown is replaced by clear make-up water. Therefore, the remainder ($450{,}000 - 68{,}400 = 381{,}600$ gal) must be filtered within 0.9 day, i.e. 294 gpm.

If the filter is designed for a filter rate of 3 gpm per sq ft, the required area for flow rate of 294 gpm is 96 sq ft. This would require one 11-ft diam filter or two 8-ft diam filters. Assuming 24 in. vertical rise per minute, the back-wash rate of the 11-ft diam filter would be 1435 gpm and the back-wash rate of the 8-ft diam filter would be 718 gpm.

● **Acknowledgment.** The writer is indebted to Wayne L. Shorb for the faithful performance of most of the analytical work and observation of data during the test runs.

Literature cited.

1. American Water Works Association, *Manual on Water Purification and Treatment*, 1941 ed.
2. Hammerschmidt, E. G., *The Petroleum Engineer*, March, 1945, p. 192.
3. Hammerschmidt, E. G., *The Petroleum Engineer*, November, 1940, p. 44.
4. Hoover, C. P., *Water Supply and Treatment*, 5th ed., p. 33.
5. Roe, Frank C., *Water Works and Sewerage*, April, 1945.

★ ★ ★

RAG DRIER

THE capricious West Texas winds have caused many a pumper to curse when he discovered that the wiping rags he had so carefully washed for re-use and hung out to dry had departed for the next county.

The rag drier illustrated here has been serving one West Texas pumper satisfactorily for some time.

The frame is made from scrap 2-in. pipe welded together and set in the ground with a post hole digger. Cover is of ⅝-in. scrap sucker rod welded together and hinged to the top of the frame with butt hinges. A prop at the handle has been provided to support the weight of the cover when open.

To both frame and cover, 1-in. chicken wire has been laced with wire making a completely enclosed area with top, bottom, sides, and ends to contain the washed rags and prevent their blowing away in high winds.

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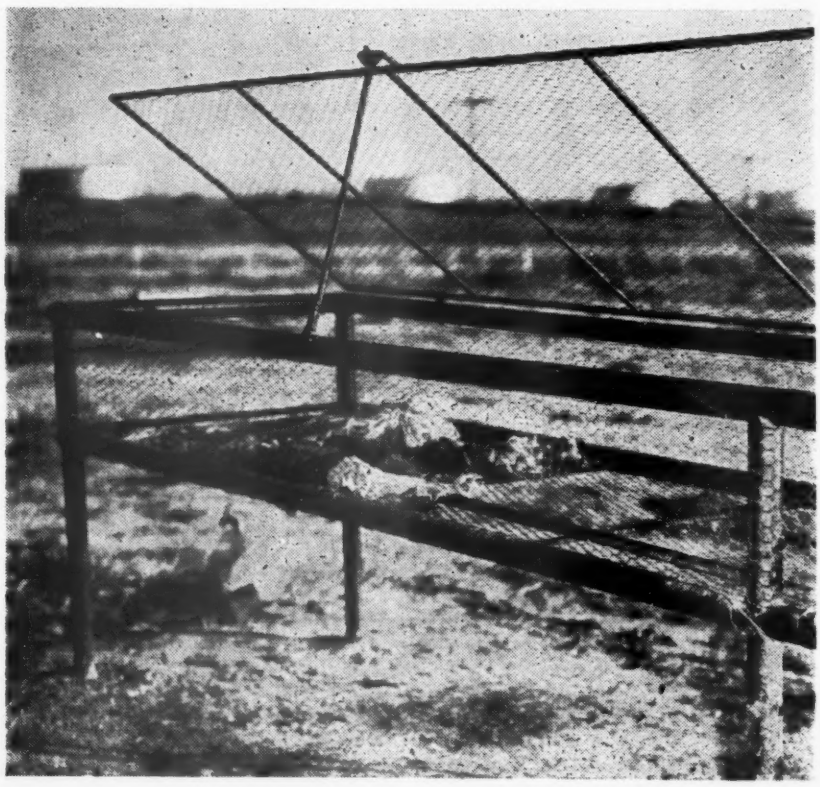

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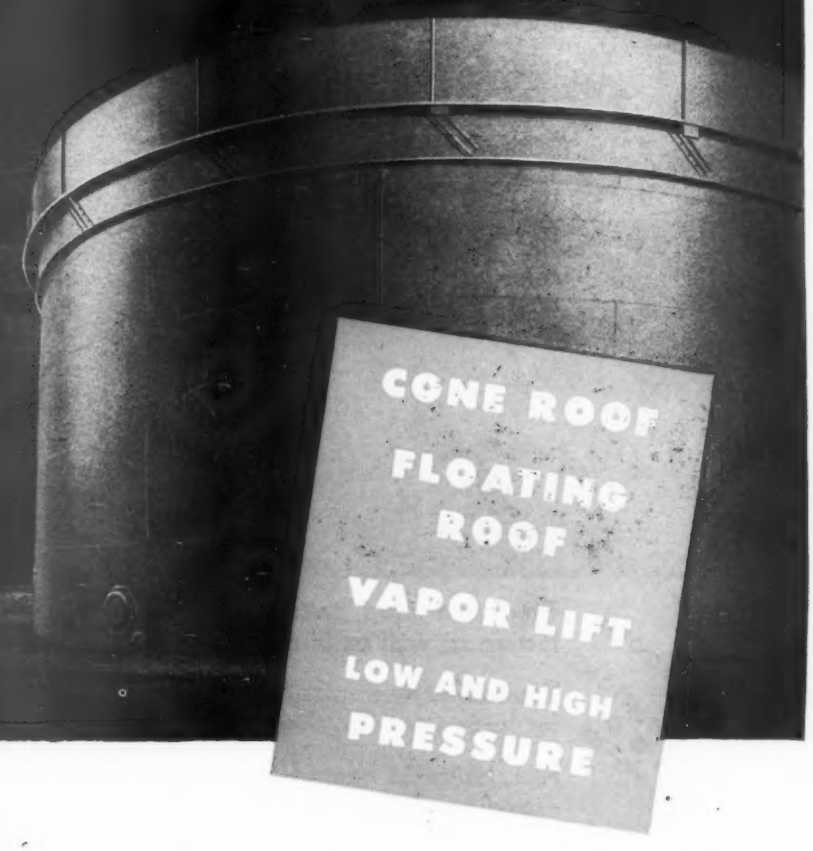

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erage 70 per cent or more per barrel processed. The heaviest movements of such products are from Venezuela and the Netherlands West Indies. Most of the residual fuel oil imported by the United States this year is received from this area. Few crude oils produced in the United States yield such substantial quantities of residual fuel oil. Economically, American oil producers stand to benefit in the long run by such importation, since light crudes produced here may be depended upon to provide the growing world demand for high grade motor fuels and lubricants. These, after all, are the products that dictate the market value of American crude oil.

Crude oil imports this year are expected to be in about the same ratio to U. S. refinery operations as they were in the prewar years, 1935-39. Runs to stills in the United States this year will aggregate about 1,723,000,000 bbl., with foreign crude imports of about 47,000,000 bbl. These imports will represent 2.7 per cent of this year's total U. S. still runs. In the prewar period, as shown in Table 4, the relationship was exactly the same, namely 2.7 per cent crude oil imports of the average annual still runs by U. S. refineries. Imports of all refined products this year are expected to be in the ratio of 5.1 per cent of U. S. refinery operations. This compares with 2.3 per cent imports to average annual refinery runs in the prewar period, 1935-39. Here, again, the increased ratio is accounted for by the necessary imports of residual fuel oils. Considering residual fuel oil imports as a necessary supplement to supplies provided by our own refining operations, it is evident that the relationship of refined products imports to U. S. refining operations is equitable to the overall economic supply and demand picture.

World crude oil production this year is expected to be about 425,000 bbl. a day greater than it was in 1945. Most of this increase will be contributed by Venezuela, Iran and Arabia. Venezuela is now producing 1,250,000 bbl. daily, and fields of the Middle East have stepped up their output to nearly 600,000 bbl. daily. These areas will account for at least 400,000 bbl. a day of the world's increased crude production this year. U. S. crude production will probably show an increase over 1945 of about 25,000 bbl. a day. These figures give some idea of what is happening with respect to the oil supply picture outside the United States. They point definitely to vastly greater potential supplies of foreign oil, which cannot fail to affect near-future foreign outlets for American oil.

From an economic standpoint, it appears unlikely that the United States may again de deluged with imports of foreign crude oil. Much of the crude produced outside the United States, which is definitely destined to grow in volume, will be refined at strategic refining and distribution centers abroad. As the demand for petroleum products increases to conform with growing world requirements, more and more petroleum products will be supplied by foreign sources. This can only mean that the United States will not be able to maintain its world position as a net exporter of crude oil and products. In the years immediately ahead it is not unlikely that the United States may become a net importer of petroleum and its products.

When economic conditions in the rest of the world are again restored to normalcy, and when civilian and industrial demands for petroleum products resume their long-term upward trend, consumption of light petroleum products and lubricants should place American producers and refiners of crude oil in a decidedly favorable economic position. High gravity crudes, which are not as plentiful elsewhere as they are in the United States, will offer profitable markets for aviation gasolines, motor fuels, lubricants, and specialty products produced here. Heavier products, such as residual fuel oils and asphalt, available in large quantities from foreign crudes, may be expected to provide that deficiency in the United States. This may mean, however, that imports of heavy products and certain special grades of crude oils into the United States will more than offset the exports of light products and specialty products produced here.

Volumetrically, we may become net importers of oil. Monetarily, we should become net exporters. ★★★

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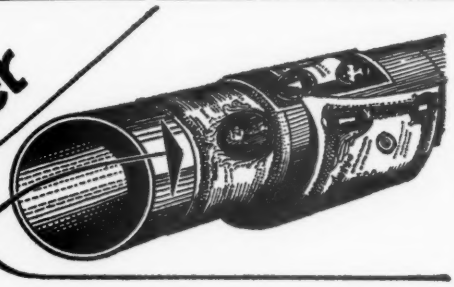

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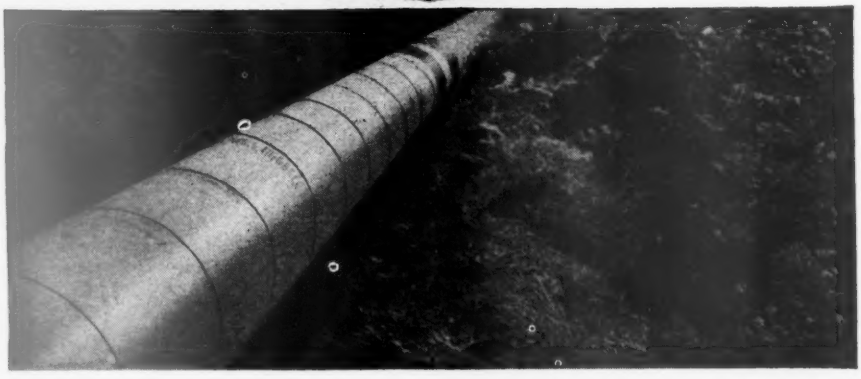

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Safe practices used in handling pipe

By **DON ATTAWAY,** *Safety Engineer,*
Arkansas Fuel Oil Company

EXCLUSIVE

RECORDS of the National Safety Council for its contest year 1945-1946 show that oil and gas pipe-line operations suffered 11.02 lost-time accidents for each million man-hours worked. This is only a 1 per cent reduction from the previous year.

These accidents have been adding heavily to the expense of pipe-line construction and operation, for actual records prove that the indirect or hidden costs of accidents are four times the direct cost.

The hazards of pipe-line construction and operation range from falls and burns to drowning and electrocution. Hardly a known accident agency is missing from the dangers of this operation.

The statistics reveal that the pipe-line worker's hands, fingers, back, legs, feet, or toes are injured in 76 per cent of the accidents and that these mishaps result mainly while handling material such as pipe, fittings, and tools.

This article, therefore, will not attempt to cover all the operations of a pipe line and its related hazards, but will confine itself mainly to the most important safe practices relative to the handling of pipe.

● **Training.** The first requisite of safety is the proper selection and training of personnel. The energy required for handling pipe requires that employes be in good physical condition and no man should be employed for this work without first undergoing a physical examination by a physician.

After examination and acceptance, the foreman should use good judgment in placing the man in his crew. This is determined by the amount of experience the man has had and physical make-up.

There is no doubt in the writer's mind but that 90 per cent of the foreman's duties should consist of job training. It is his main responsibility to instruct and teach safe methods required by the job.

● **Lifting.** The most common physical act required in pipe-line work is lifting and consequently a great number of lost-time accidents result from this operation.

The causes of these lifting injuries are known and methods of correcting the hazards are definite and practical, but a great many men still do not know how to lift safely and correctly. Lifting injuries are often quite serious and average time losses are 7 to 19 weeks.

Most lifting injuries are caused by one or more of the following factors:

1. Overtaxing physical fit workers.
2. Lack of proper lifting equipment.
3. Lifting in wrong position.
4. Physically unfit workers.
5. Uncoordinated teamwork.
6. Poor housekeeping (insecure footing.)

The supervisor is responsible for studying and analyzing all lifting problems and determining the type and amount expected of a workman. He should also install mechanical lifting equipment wherever practical or devices whereby lifting can be eliminated or reduced. The speed or pace of the work to be done by individual employes should be controlled to safe limits.

In lifting each man should:

1. Face the load with feet apart so that no undue strain will be on the abdominal muscles. The stance should be natural and comfortable.
2. Bend the knees to get down to the load and keep the back erect.
3. Raise the load evenly, without sudden jerk or strain, by straightening the legs to take the load on the leg and shoulder muscles.

Generally speaking, a pipe should be lifted or carried by a team of two men or more. Such men should be of the same general height and physique. They should walk in step while carrying the load, and the pipe should be carried on the same shoulder of each man.

The shoulder carry is generally safe and satisfactory if the pipe is held and balanced with both hands and lowered or dropped evenly. If two men are carrying the pipe, they should have a definite understanding of signals and their job.

If man at rear drops or throws his end of the pipe . . . man at front may be thrown to the ground and injured.

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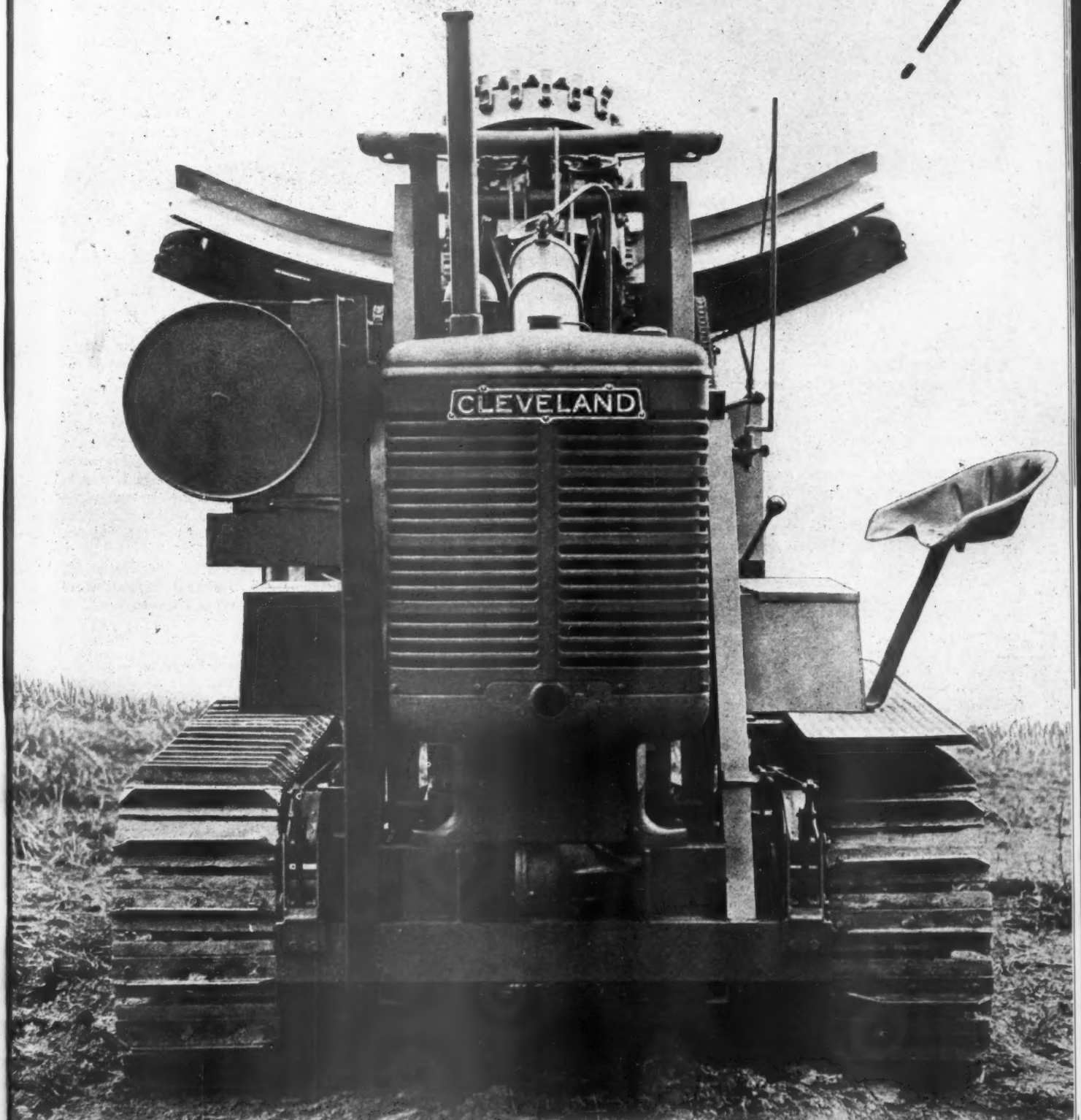

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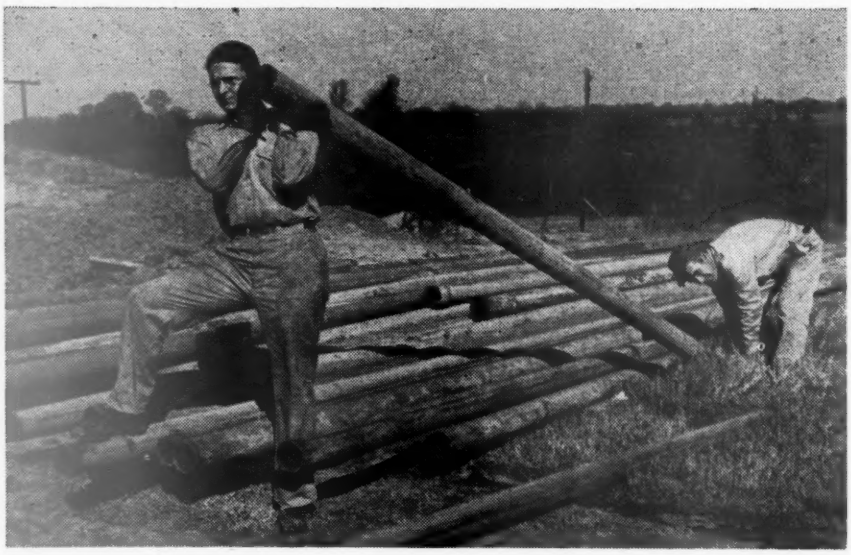


These two men are handling pipe incorrectly.

The load should not interfere with a normal walking gait and their vision ahead should not be blocked.

● **Racking pipe.** The pipe required for lines is usually stored in warehouse yards and racks. It is a safe practice to rack pipe in piles no higher than 4 ft. Each tier of pipe should be separated by substantial strips and blocked adequated at each side. These strips should be at least 1 in. material and the pipe should be racked evenly in a vertical direction to prevent pinching of strips.

The rack weight capacity should be such that five tiers of pipe will not overload it or extend past a worker's shoulders. For safety, workmen on the ground on each side of the rack should be able to see each other at all times.

Wooden rack supports should be at least 10 in. by 12 in. and strongly cross-braced. Such racks should be inspected at frequent intervals for rot or decay.

The bed of pipe racks, whether metal or wooden, should not be above truck bed level and the surface of driveways for truck approach should be level and parallel to the rack.

In racking pipe, gloves with leather palms and approved goggles should be worn.

In handling sharp edge pipe, a hardwood hand-stick makes the job easier and safer. Using the hand in open end of pipe exposes it to cuts and bruises.

When pipe of the same size in various lengths is being racked, the longer pieces should be on the bottom. Uneven load distribution is a common cause of rack collapse.

Pipe should not be skidded across spans greater than 12 ft and the skid poles should not be set at an angle greater than quarter pitch. The skid must be of heavy, strong material and so placed that it will not kick or jump out of position and allow pipe to fall.

Unloading and racking pipe from flat cars or gondolas usually requires a gin pole or winch line. Extreme care must be taken at all times to keep workmen in the clear. Cables and lines used in this operation must be kept in good condition.

● **Pipe truck loading.** Each truck and trailer has a load capacity permit and safe drivers know their truck limits. Trucks should never be loaded beyond capacity.

In handling pipe from the rack to the truck, workmen should never take a position between the truck and rack until the pipe has been securely checked or secured in place.

The bottom layer of pipe, or bed load should be secured and evenly placed on the bolster by chock pins on each side of the bolster. The use of chips, clods, etc., as temporary chocks is very hazardous.

The bed layer is the key to the entire truck load and it should be so placed that ample clearance is left between the cab and the ends of the pipe to permit the bed bolster to turn freely an sharp curves. The overhang must not be too great and an acurate tally made of every load of pipe to be sure the driver knows his exact number of joints and load weight.

The fully loaded truck must not be moved from the rack until it has been firmly chained and boomed. If pipe is of extra length, a center chain should be required. Workmen should keep from beneath the load until it has been boomed.

The pipe on the rack must be securely wedged before the crew leaves the job.

Each truck driver should stop after driving a short distance and inspect his load for position and secureness.

● **Stringing pipe.** In stringing pipe along an open ditch, the truck should be on the side opposite the excavated earth and far enough from the ditch edge to prevent caving of the trench wall.

Pipe joints should not be thrown off with the truck in motion. Many drivers think this practice is a time-saver. The

This pipe crew is handling pipe in a safe manner. Men are wearing goggles and working in the clear. Strong skids and substantial strips are used.
—Photo by J. E. Hampson.

Pipe line crew applying protective coating on pipe. This is a corrosion-resistant chemical that may be applied by mop, sling, or gloved hand if the pipe is clean, and smooth.

truck should be at a standstill when the joint is dropped as this not only makes proper spacing possible but eliminates the possibility of a joint catching under a wheel or in the truck frame and upsetting the entire load.

Workers should stay a short distance behind the truck while it is in motion so that saplings and dead limbs will not be snapped back into their face. They should never walk on the ditch edge or side where falling joints may strike them.

The top row of pipe must be the first joints strung. Slipping joints out of the middle or side of load is bad practice.

The back end of the joint should be dropped first to prevent side-lash or kickback. Proper handling reduces damage to pipe ends or threads and eliminates extra handling by the laying crew to bring the pipe into position.

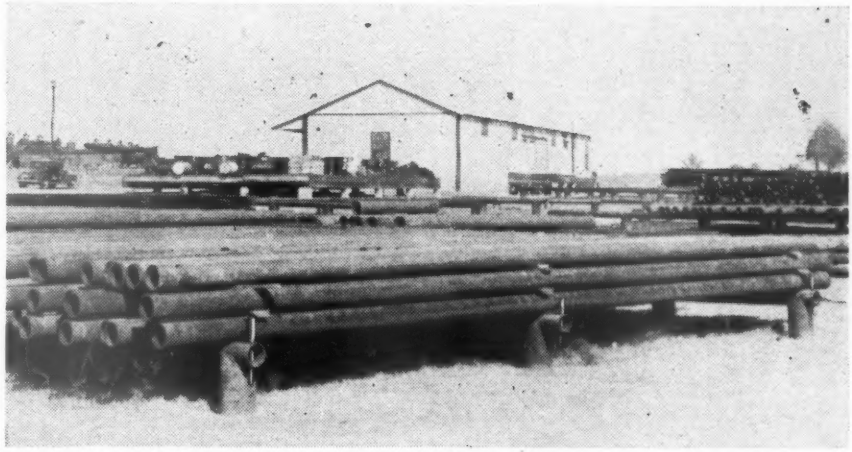
The truck helper should not attempt to lift ends of heavy or wedged pipe joints. A pinch bar or hardwood hand stick is useful in prying apart pipe ends.

Stringing crews should not attempt to take truck loads of pipe across deep ravines, mud flats, and hazardous places. Such pipe can be safely strung by team or hand.

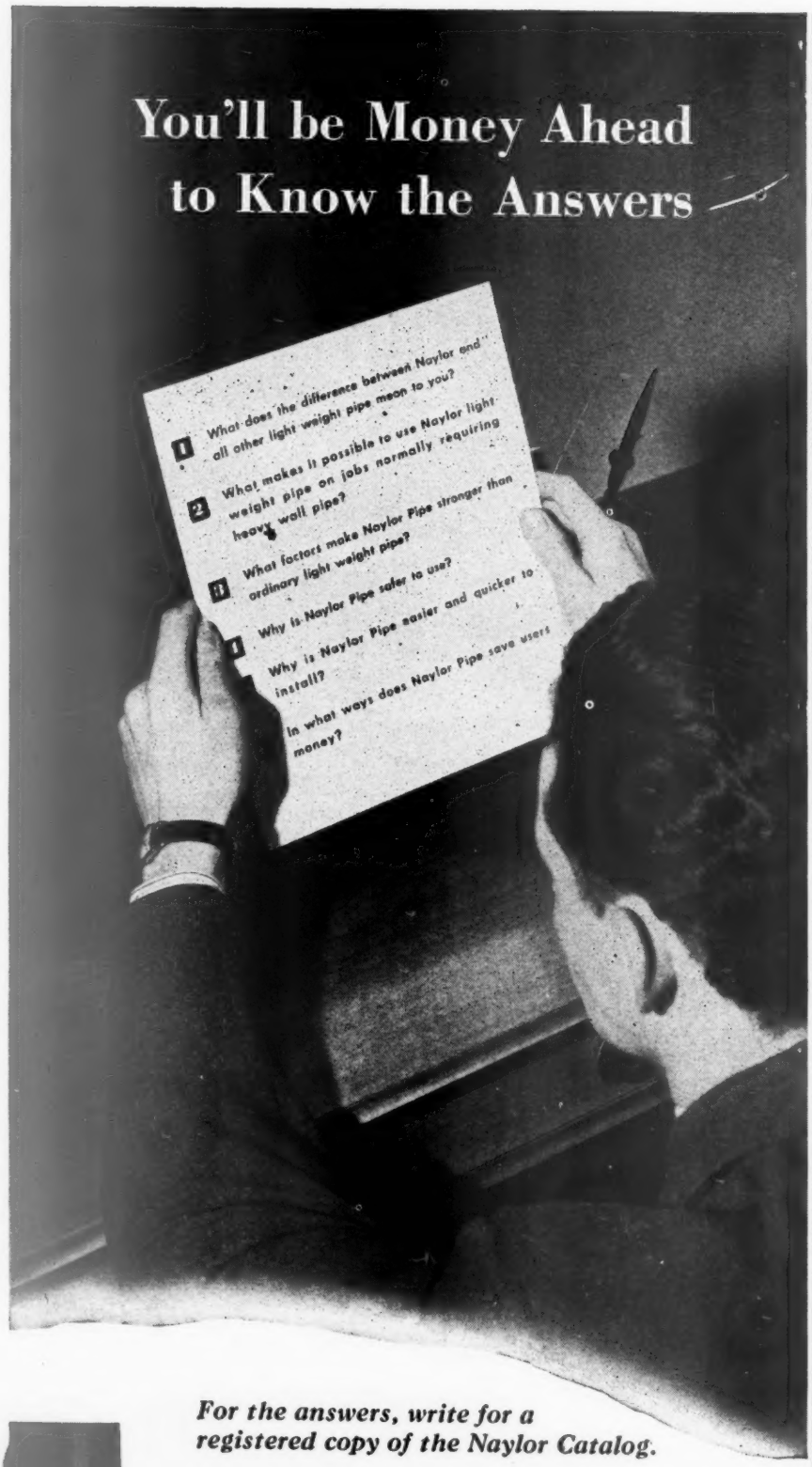
The truck should avoid driving over dropped barbed wire fences as the wires may tangle and hang under the truck. Proper gaps should be cut for such crossings.

No less than four men should attempt to carry a 20 ft joint of 4-in. pipe. Pipe in smaller sizes can be handled safely by two men. Pipe of a larger size requires many more men and should be moved by truck or team.

In carrying pipe manually, the joint should be supported by carry-irons and not lifted by means of the hand in the open ends.



***Above*, a typical field warehouse and pipe rack yard. Note correct height, stripping, and pins in racks. *Below*, lowering crew using pipe frame and rope-wrap. Substantial footing of frame and use of chain tong for safety latch are correct measures.**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● **Laying pipe.** Screw-end pipe has sharp threads and laying crews should wear gloves while handling such pipe.

All skids used under the pipe should be strong and solid and, if placed across an open ditch, should extend well onto solid earth.

In lining up the pipe, the hand must be kept out of the open end and from under the pipe. A bar or prypole is best suited for spatting pipe.

In laying coupled pipe, the holes in the rings should be lined up with a spud wrench and not pulled or turned with the fingers.

Plain end pipe for welding is often beveled to a sharp edge and care must be used to prevent striking the person against the pipe end.

● **Pipe coating.** Many lines are protected from corrosion by special wrapping or coating. Usually the lines are brushed or cleaned for this treatment. It is imperative that workers wear goggles for this operation.

The use of asphalt or tar coating is popular because of its low cost, ease of application, and degree of protection obtained, but this operation requires heating the material and spilled liquid will burn the skin badly on contact. All men should wear goggles and gloves for this operation and clothes that completely cover the body.

Certain rust-resistant greases or chemicals may be applied with mops, slings, or gloved hand.

● **Lowering pipe.** Lowering pipe into a ditch requires proper equipment, care, and teamwork. This operation is best started from either end of the line instead of the middle.

Large diameter lines are usually lowered by means of a winch, gin pole, or frame operated from a truck or tractor.

In manually lowering lines, several turns of rope are wrapped around the top of the frame and the pipe lifted for removal of the skids. The pipe is then lowered slowly with tongs holding a back-up or brake to prevent slipping. Only strong, sound rope should be used for this operation.

Small diameter lines are usually lowered by means of hand-lines and this should be done with caution. Such lines are very elastic and, if thrown into the ditch, strains or breaks may result from such handling and the limber pipe may back-lash and strike workmen.

● **General.** There is every proof that if the fundamentals of safety are taught and practiced, accidents and property damage resulting during handling pipe, can be reduced to a minimum or eliminated. This requires good equipment properly maintained, carefully selected trained crews, and efficient supervision.

● **References.**

1. "Safety in Pipe-Line Construction" by A. W. Breeland, *The Petroleum Engineer*, March, 1941.
2. Special Bulletin No. 11, U. S. Department of Labor, Division of Labor Standards.
3. National Safety Council, Safe Practice Pamphlets Nos. 17, 23, 41, 79, and 105.

★ ★ ★

Pipe line provides outlet for new gas discoveries

By **E. H. FISHER,*** *Chief Engineer*
Pacific Public Service Company

Ditcher working in the Montezuma Hills section of Pacific Public Service Company's $900,000 Suisun Bay natural gas pipe line.

Welding a new length into the Suisun Bay pipe line in California.

A NEW source of natural gas was made available to central California's growing residential and industrial centers east of San Francisco Bay with the January completion of Pacific Public Service Company's $900,000 gas pipe line.

EXCLUSIVE

This Suisun Bay pipe line will gather natural gas from approximately 17 wells in the inaccessible Sacramento River delta region for delivery into the Standard Pacific Gas Line at Pittsburg. The pipe line system is designed for a working pressure of 800 psi, providing a delivery of 57,500,000 cu ft per day at 500-lb field pressure.

E. H. Fisher

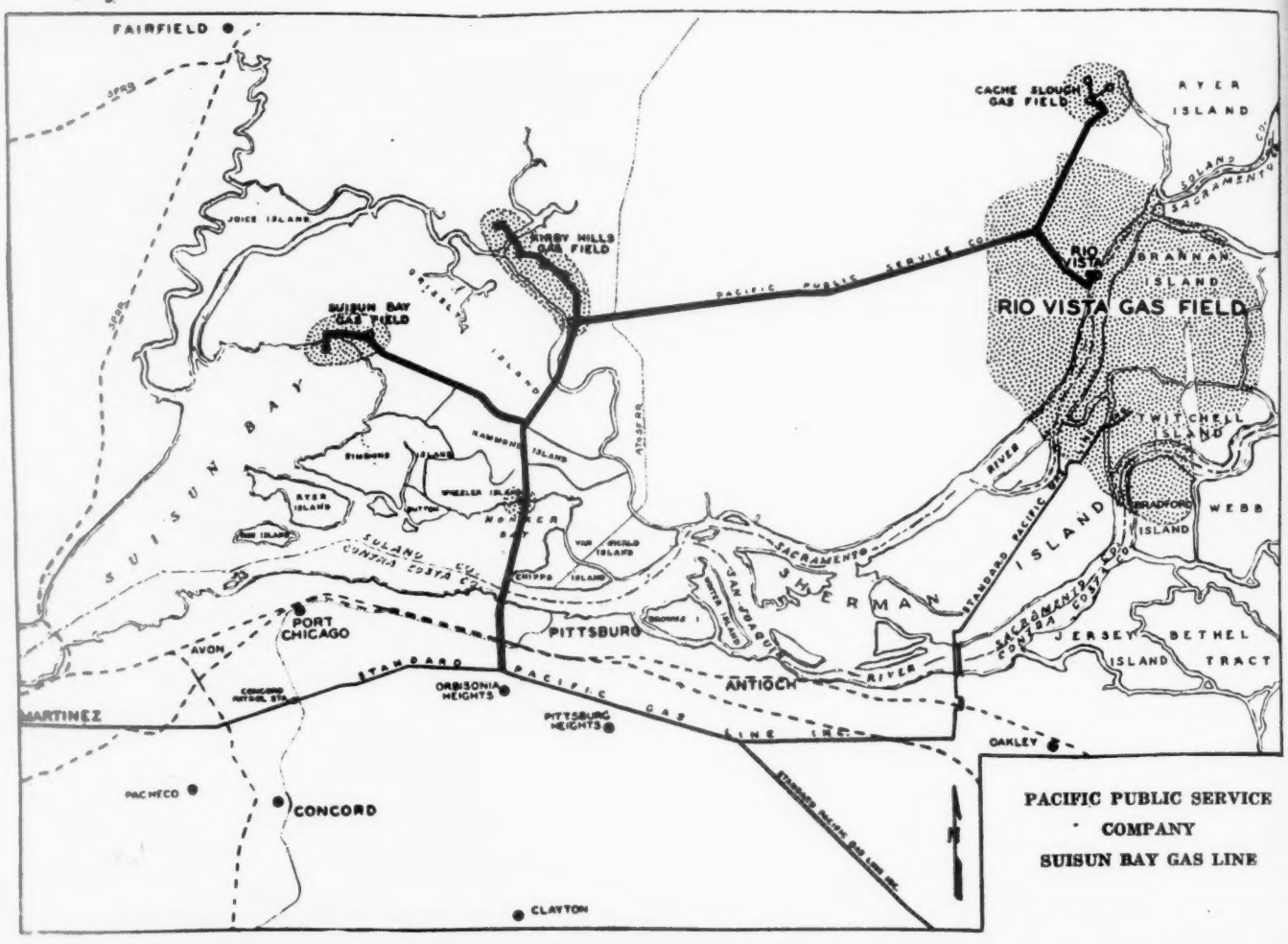
The new gathering and transport system has been built of pipe ranging from 4 to 12 in. in diameter. It will take production from wells in the Suisun Bay, Kirby Hill, Honker Bay, Cache Slough, and West Rio Vista gas fields, which have a combined production rate of 108,000,000 cu ft a day.

● **Line to serve dual purpose.** Begun on August 26, 1946, this pipe line system will serve the dual purpose of providing an outlet for recent natural gas discoveries, and also supplement and increase Pacific Public Service facilities for serving an increasing domestic and industrial market. The line will also provide an additional outlet for gas from the west side of the Rio Vista field.

Construction has included, due to the nature of the country through which the line is built, water crossings totaling more than three miles. Largest of these is the 13,400 ft crossing of the Sacramento River channel and Honker Bay at a point near Pittsburg. The line crosses a number of sloughs, although only two are considered navigable, namely Montezuma Slough, which is 500 ft across and 31 ft deep, and Nurse Slough, 600 ft wide and 23 ft deep. Dredging operations were necessary to bury the pipe 4 ft under these two sloughs.

As in the case of slough crossings, pipe for the Honker Bay project was prefabricated in long strings, two of which were nearly a mile in length. The lengths were pulled across the channel by barge derricks anchored in the stream, using steam winches to move the long strings of pipe into position. Once in place, the lengths were hoisted from the bottom of the bay, and welded into one piece. The Honker Bay portion of this largest crossing is 9100 ft, and ranges in depth from 4 ft to 9 ft

*E. H. Fisher, chief engineer of Pacific Public Service Company, has been connected with this corporation since he received his electrical engineering degree at Stanford University in 1929. He has held his present position for the last seven years. Prior to that time he was superintendent of operations and construction at Pittsburg, California, for Coast Counties Gas and Electric Company, Pacific Public Service subsidiary.



Welding crew lining up pipe in the Montezuma Hills section for the new Suisun Bay natural gas pipe line.

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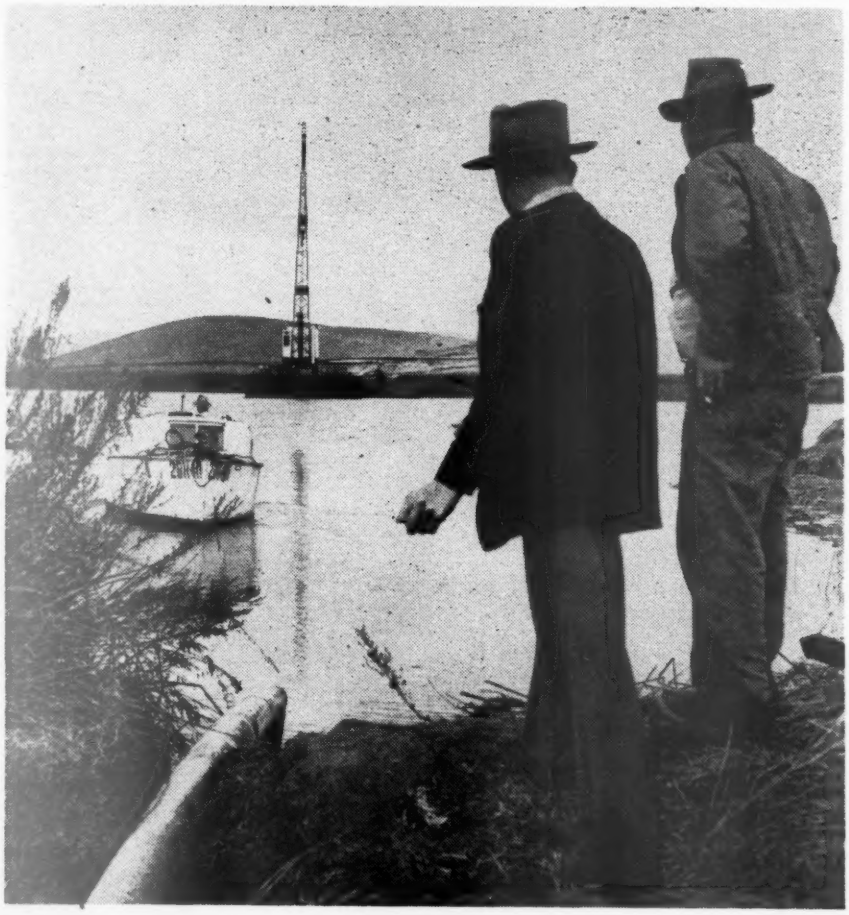
Bringing pressure to 1000 psi to test section of Suisun Bay line prior to pulling this 600-ft portion of line across Nurse Slough.



Six hundred ft section of pipe line starts across Nurse Slough, being pulled by steam winches aboard dredging barge in the background. This was one of several water crossings necessary for construction of new Suisun Bay pipe line.

at the low-water level. The river channel portion of the crossing, 4200 ft wide at this location, is about 55 ft deep at the deepest point measured from the low-water level. Design of the crossing provided for minimum cover in the channel of 4 ft, and in Honker Bay 1 ft of cover.

● **Gas well in the water.** Other water operations necessary for construction of the new pipe line included laying of a gathering line to a well located in Suisun Bay about 1600 ft offshore. The main to this well was buried 6 in. below the bottom of the bay. The well is completed in two sand structures, one to be produced through the casing and the other through the tubing, thereby requiring two individuals meters. Metering equipment was installed on a platform supported on piling above the high tide level.

Because access to areas in which some of the discovery wells are located is difficult even in dry weather, and all roads impassable in the rainy season, it was necessary to bring all pipe, equipment, and other materials into these locations by water. Materials and machinery were loaded on barges and floated up Monte-

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zuma Slough to landing points for further distribution.

Construction of the line was also scheduled so that work could be done in the driest season of the year in the area covered by Wheeler, Hammond, and Grizzly islands. This area is mostly low swamp land with a fairly high water table.

Wheeler Island is purposely flooded, too, about October 1 of each year and prepared for duck season. In order to cooperate with land owners, it was necessary to complete the pipe line construction in this general area and minimize the traffic by October 1 so as not to interfere with a successful hunting season.

● **Buried three feet.** Where land has been reclaimed and levelled for cultivation, the pipe line was buried with 3 ft of cover. Where land was reclaimed but awaiting improvement for cultivation, pipe was buried with 4 ft of cover. Other portions of the line were put 18 in. under the surface.

The delivery into the Stanpac line is large enough to indicate the need of either a 24-hr attendant or some other means of supervision. This problem is to be met through the medium of telemeters. A flow and pressure telemeter will be installed at the terminal, together with carrier equipment, utilizing the Stanpac telephone circuit for transmission to receiving equipment at the Antioch control station. Duplicate receiving equipment will be installed at the Pacific Public Service office at Pittsburg. Arrangements also call for installation of a recording gravitometer.

● **May use radio communication.** Because of the difficulties of transportation and communication between the fields north of the river and the transmission system south of the river, it is probable that considerable reliance will be placed on radio communication for actual operation of the new pipe line. Two of the producing companies at Rio Vista now have such equipment, and it is probable that it will be utilized in combination with telephone communication in operation of the line.

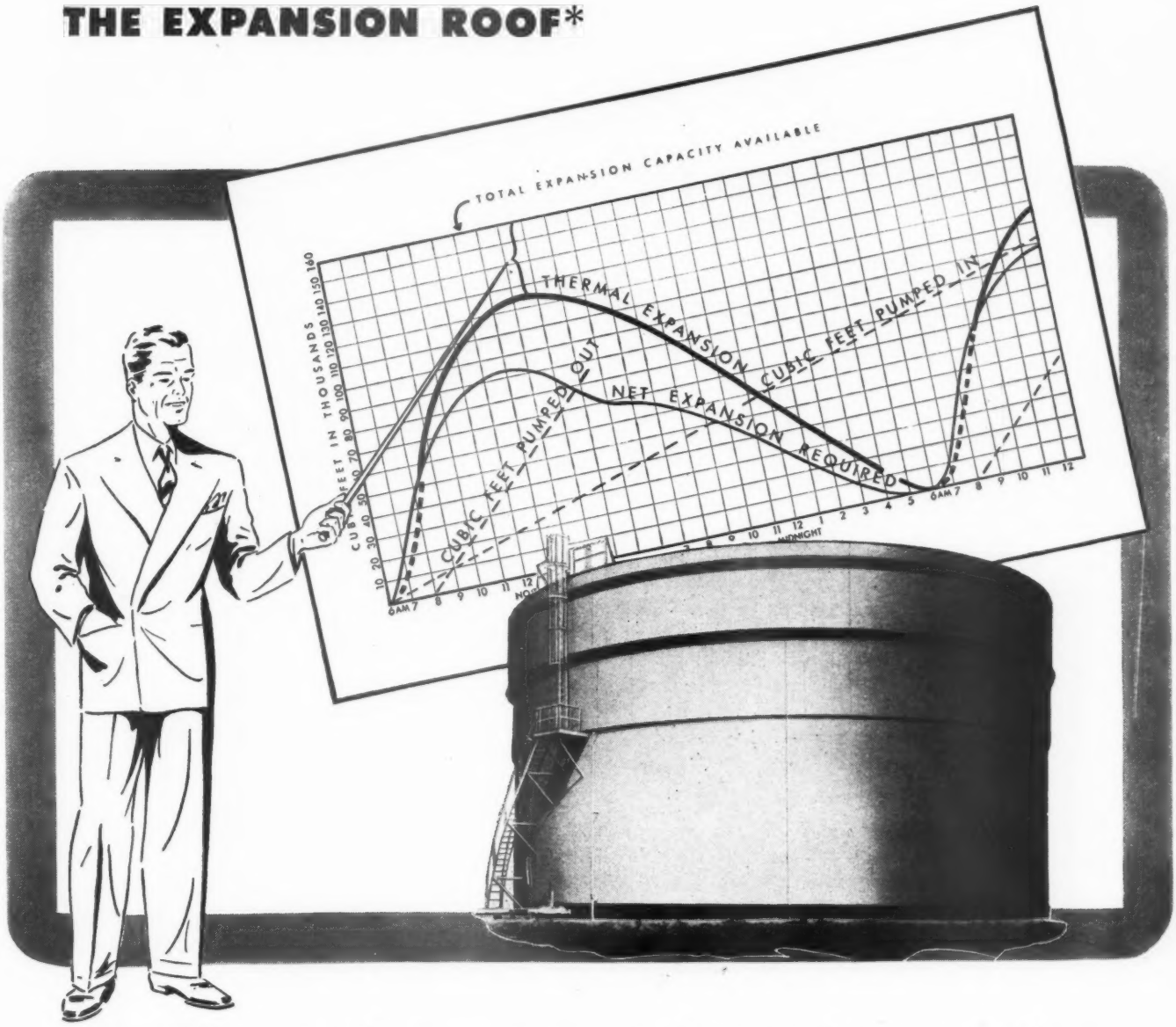
Provision has been made to remove water and condensate from the gas prior to delivery into the Stanpac line. The equipment for this job consists of four drop leg drips situated along the line at the lower points, plus a scrubber of sufficient capacity to handle 70,000,000 cu ft per day at a pressure 300 psi. This scrubber is designed to extract the liquid that forms what is known as retrograde condensate at lower pressure and exists in the gas as a fine mist at this stage.

All pipe going into the line was first pheric pressure; is therefore negligible. Somastic coated by Bechtel Corporation at its plant in Pittsburg, and the coating later tested with electronic equipment after lengths had been welded into the line, and before lowering into the ground.

Contractor for building the line was Pacific Pipeline Construction Company.

★ ★ ★

THE EXPANSION ROOF*


TOTAL EXPANSION CAPACITY AVAILABLE
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NET EXPANSION REQUIRED
CUBIC FEET PUMPED OUT
CUBIC FEET IN THOUSANDS
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6AM 7 8 9 10 11 12 NOON 1 2 3 4 5 6PM 7 8 9 10 11 12 MIDNIGHT

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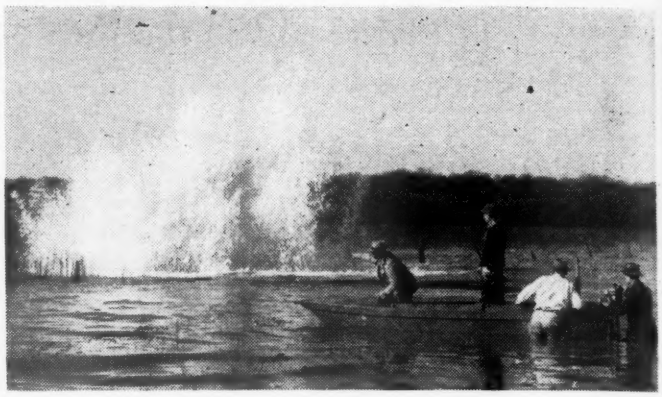
P 625.4

Repairing pipe line in flood waters

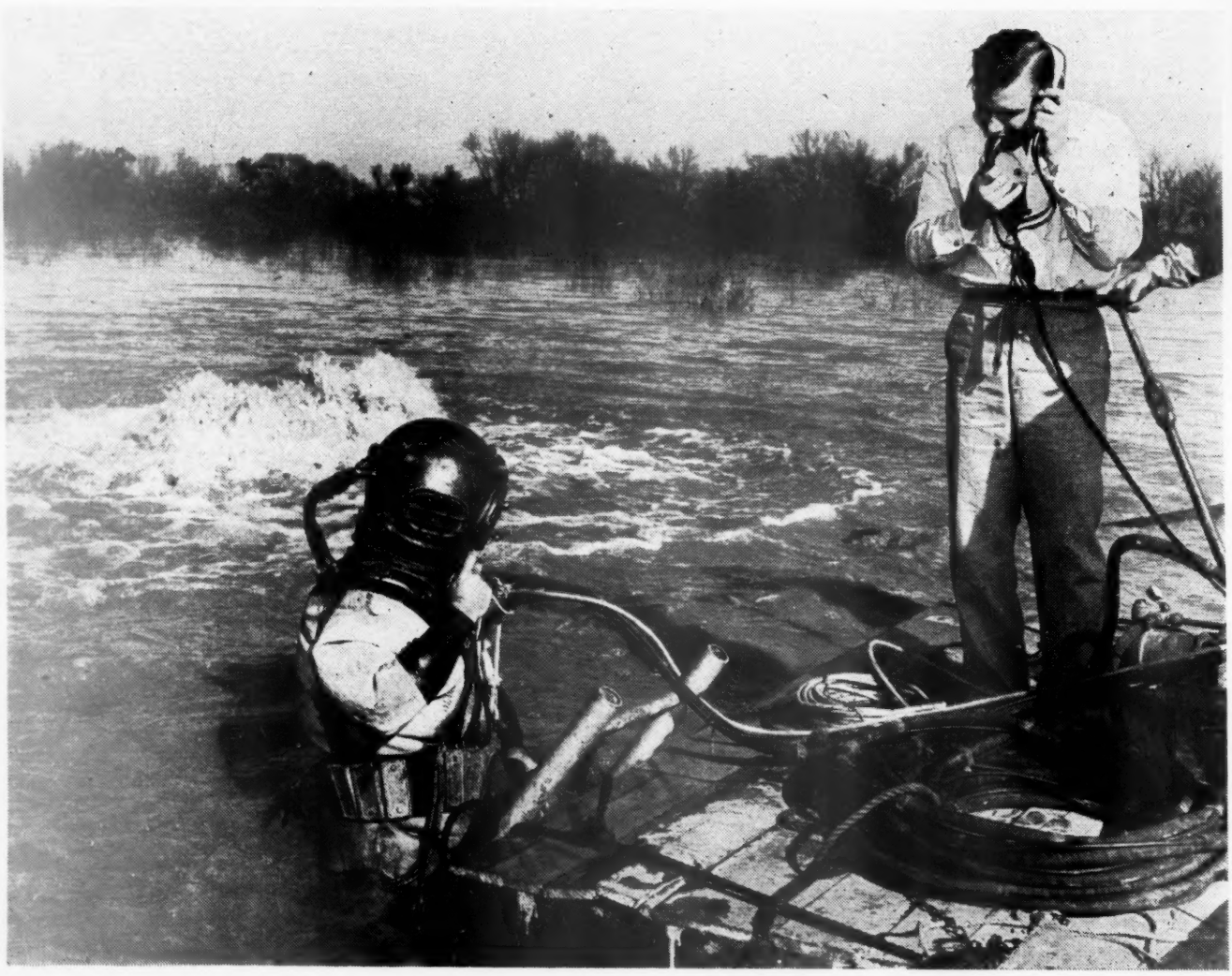
By **CLARIBEL THOMPSON**
Lone Star Gas Company



LONE STAR GAS COMPANY pipe line men got a taste of Gulf Coast operations when one of the company's five big lines serving Dallas and 34 East Texas towns, had to be repaired in mid-December under 16 ft of Trinity River flood water. Picture at top right shows pipe line crew that scouted for the break in a small motor boat. Although gas supply had been cut off in the affected line, enough pressure was allowed to go through gate station to cause a water geyser and assist in locating break.

EXCLUSIVE

Repair work was completed with the aid of a Houston diver and a "land" crew from Oklahoma Contracting Company, after a seven-day battle against floodwaters, mud, and bitter cold weather. Men in scouting party included D. O. Welch, shown in boat prow pointing at water geyser in top picture. He is Dallas district assistant pipe line foreman for company. Below are Diver J. E. DeForest and tender, Lester Cole, shown readying for preliminary inspection of the line break. They worked from improvised raft. Churning water behind diver marks spot where break occurred on the 18-in. line. Underwater repairs were directed by telephone communication between diver and his tender.



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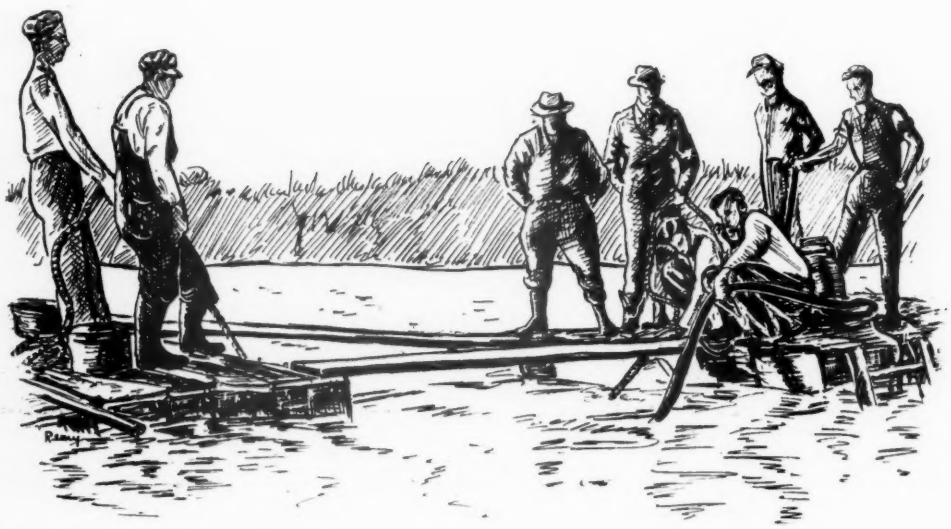
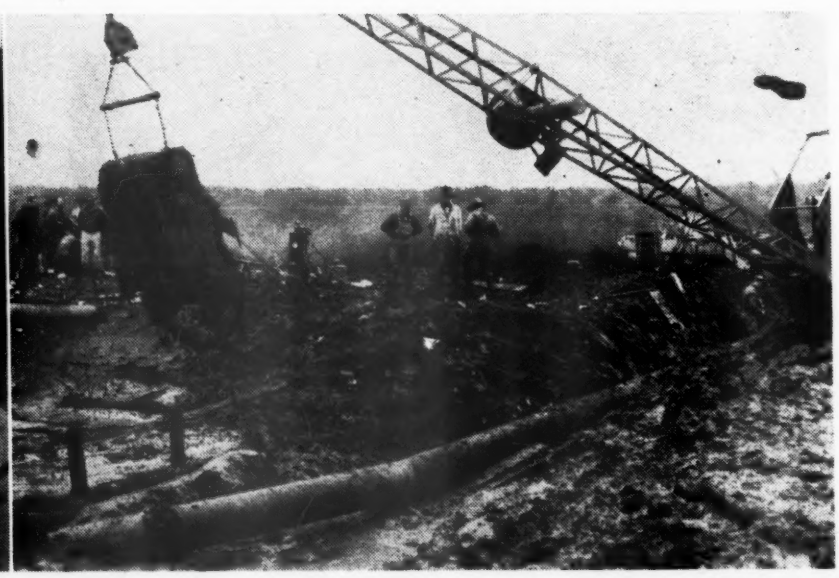
Left, R. Vandercook, Lone Star pipe line superintendent, and Luther Tolbert, assistant, hold motor boat conference with diver to decide best means of repairing underwater line break. Holding chain to boat is Earl Miller, pipe line construction foreman. Diver DeForest tells officials break was caused by rush of water and the pulling apart of a coupling. He suggests placing of a new split sleeve around the break, to be done under water in order to rush repairs and put line into service.

In sketch, diver and men work from two rafts maneuvering 500-lb split sleeve into place over the break. Heavy sleeve was lowered over side from rafts by use of heavy manila ropes. Telephone communication between diver and tender aided in directing operations of the men on the rafts, coordinating their work with that of diver working below.

Below, left, Charlie Ives, Oklahoma Contracting Company, walks waist deep in mud hole where second break on Lone Star line occurred during December flood. Ives is standing on line, which was reached by building coffer dam around break and pumping water out. Pumping operations are shown in background.

Right, drag line was used to build coffer dam around line break as men prepared to cut out broken section and replace with new section of line, which was welded.





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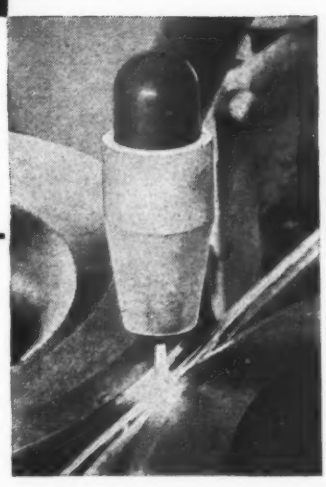

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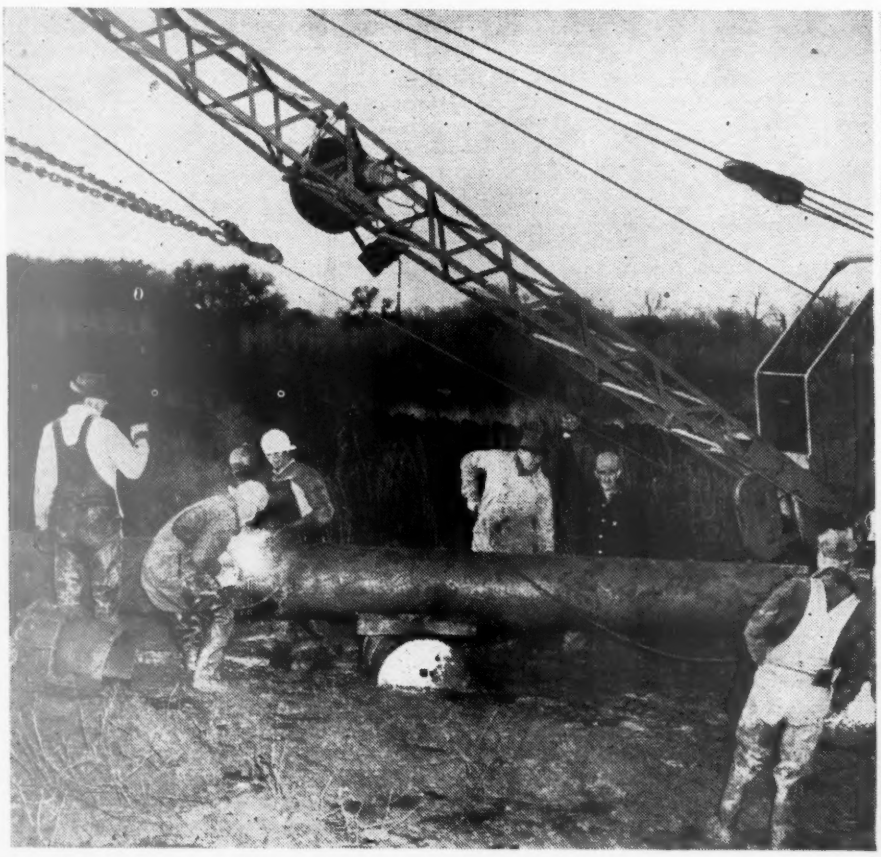
Caterpillar tractor, at right, moves welding unit into place as repairs begin on second break. Mud was so deep that hip boots and even waist boots worn by some of the men, were often inadequate. Note the mud sled at left of picture, made from 2-in. gas pipe for runners and heavy planking for platform. This was the type used to bring in the smaller equipment. Heavy equipment was moved in over two-mile route as break could not be reached over inundated short route to the highway.

Welding in of new section of line begins as damaged section, at left, is cut out. When this work was finished the line was ready to be put back into service, seven days after the first break was discovered. Oklahoma Contracting Company welder is shown assisting Lone Star welder in final operations as drag-line crew stands by to lower repaired line into place. Weather was bitter cold, lowered to 18 degrees later.

Dramatic moment was when line was purged of mud and water following repairs. It was cleared by turning gas into main at one gate station and blowing it out through gate valve near second station, close to which breaks occurred. The line was purged for several hours before service could be resumed.

★ ★ ★



(Above) **Two 500 hp main line pumps.**

(Right) **Exterior view of the above pipe line station. Building costs are at a minimum because of smaller structures, lightweight materials, absence of heavy cranes, craneways, etc.**

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Internal cleaning of gas pipe lines

By **C. A. SERAFINO,** *District Measurement Superintendent,*
United Gas Pipe Line Company

NUMEROUS articles have been written on internal pipe line cleaning. This article offers an arrangement that will expedite the job when more than one scraper is to be run through a section of line. The arrangement has been used on miles of gas line ranging in size from 8 in. to 24 in.

EXCLUSIVE

The usual method of running a scraper is as follows:

1. The covering is removed from the line at the entrance and exit points.
2. Gates at each end of the line are closed, and the section is drained.
3. The line is cut and raised at both the exit and entrance locations.
4. The scraper is inserted; the pipe is lowered and then coupled.
5. A sandbag barricade is placed at the exit end to stop the scraper after it is discharged from the pipe.
6. A pressure gauge is placed at any convenient location upstream of the scraper so that the pressure behind the scraper may be controlled.
7. Gas is then admitted behind the scraper to propel it to the exit end.

Now, if a second scraper is to be run, it is necessary to wait until all the gas has drained off before removing the coupling at the entrance end. This consumes considerable time, and additional time is consumed when the pipe has to be raised again, the second scraper inserted, the pipe lowered, and the coupling again bolted up.

With the arrangement shown in the accompanying sketches, you are ready to run the second scraper just as soon as the first scraper is out of the line.

Fig. 1 shows the two parts of the scraper loading device. Part A shows a heavy blank plate welded in place to separate the high-pressure gas supply from gas that propels the scraper. Part B shows the scraper loading barrel. The drain valve on Part B is designed to accelerate the draining of the line after the second scraper is run. The orifice flange and an orifice meter are for volume measurement in running scraper.

Fig. 2 shows the assembly ready to be swung in place with the scrapers in position. Valves C, D, and E are closed. Sufficient pipe is removed from the main line so that the assembly will fit in the line. Fig. 3 shows the assembly placed in the line.

Gas is then admitted to the upstream side of valve C from the main line gate. Valve C is then opened. The No. 1 scraper is then propelled down the line by admitting gas from valve E. After the No. 1 scraper is out, valve E is closed. The No. 2 scraper is now propelled by admitting gas from valve D.

Although we have used this arrangement for only two scrapers, it is the writer's opinion that possibly four or six scrapers could be run in the same manner in a very short time. This, of course, would be necessary only when an extremely dirty section of line is encountered, and when the line can be kept out of service for only a few hours.

★★★

FIG. 1

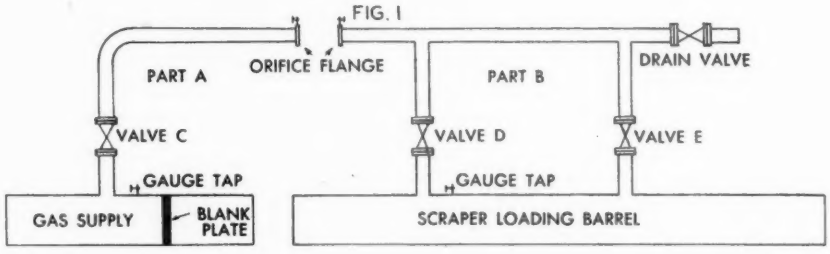


FIG. 2

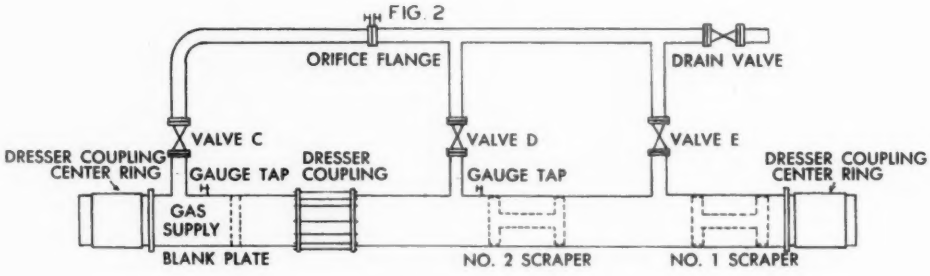
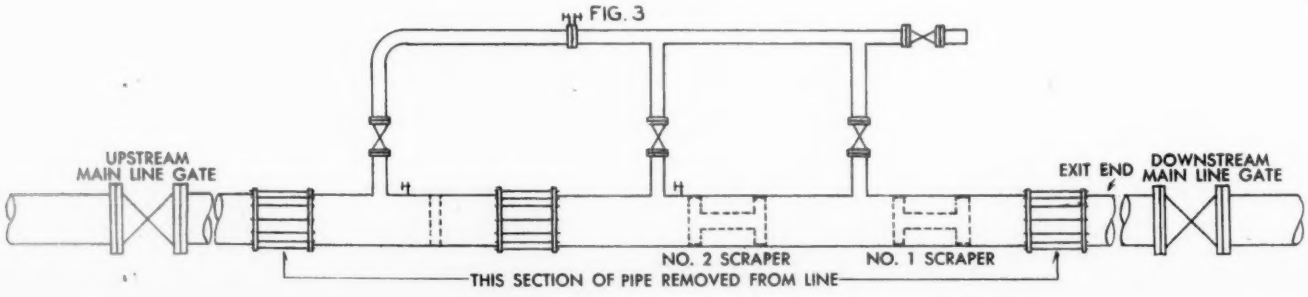


FIG. 3



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P 615.222.

Welder makes bell-hole weld on the Great Lakes Pipe Line Company's 8-in. line in Minnesota.

Pipe lines play big role in nation's economic reconversion

By **R. H. DAVIES,** *Consulting Engineer,* The Lincoln Electric Company

EXCLUSIVE

It is particularly significant at the present time to learn that millions of gallons of oil are still being pumped to refineries in the Midwest and East through pipe lines that were constructed in the last six years by the process of shielded arc welding.

These lines, threading their way from the West to the East, led the flow of vital fuels that were strategic to the victory of our allied forces during the war. These same lines are now guiding the flow of this important resource to the infinite industrial outlets that are facilitating our transition from a wartime to a peacetime economy.

The simplicity, speed, and high quality of work attained by this shielded arc process have resulted in its general acceptance in the construction of cross-country pipe lines. Contractors engaged in this work have augmented the inherent advantages of this process by adding from time to time new techniques that expedite field practices.

For speed in construction of pipe lines, particularly over flat terrain, the firing-line method is the general procedure. In this method the pipe sections are mounted on dollies and roll-welded until a sufficient length for tie-in is constructed. This length is then bell-hole welded to the main line that is already in position.

Bell-hole or stovepipe welding has proved to be exceptionally effective in the construction of lines over rough terrain, especially through hilly areas and over shallow subterranean rock fields where roll-welding of long sections would be highly impracticable. This stovepiping adds economy to the job for it is accomplished by adding one joint at a time, thereby eliminating the necessity of extra crews and welding machines, keeping the work concentrated and under one supervisor.

Under most circumstances, oil lines can be reconditioned by arc welding without interrupting the service. As a matter of fact, it is advisable to keep the line under normal pressure for this precludes the possibility of gas pockets, which readily form in empty or partially full lines.

For this line maintenance, a section is usually uncovered and brought to the surface at a time. The dirt, rust, and

TABLE 1. Recommended sizes of electrode for pipe-line welding.

Roll welding without back-up ring.

Weld beads, in.	4	6	8	10	12	14	16	18	20	22	24	26
Stringer bead, in.	5/32	5/32	5/32 or 3/16	5/32 or 3/16	5/32 or 3/16	5/32 or 3/16	5/32 or 3/16	5/32 or 3/16	5/32 or 3/16	5/32 or 3/16	5/32 or 3/16	5/32 or 3/16
Second bead, in.	3/16	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
Third bead, in.	1/4	1/4	1/4 or 5/16	1/4 or 5/16	1/4 or 5/16	1/4 or 5/16	1/4 or 5/16	1/4 or 5/16	1/4 or 5/16	1/4 or 5/16	1/4 or 5/16	1/4 or 5/16

Position welding without back-up ring, "stovepipe" or "tie in" method.

Weld beads, in.	4	6	8	10	12	14	16	18	20	22	24	26
Stringer bead, in.	.....	3/16	5/32	3/16 or 5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32
Second bead, in.	.....	5/32 or 3/16	5/32 or 3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
Third bead, in.	.....	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16

Position welding with back-up ring: Use 3/16-in. rod for all beads on all sizes of pipe.

Note: In above table size of electrode for first bead depends upon spacing. Size of electrode for second and last beads depends upon thickness of pipe. Use 1/8-in. electrode on additional beads when necessary.

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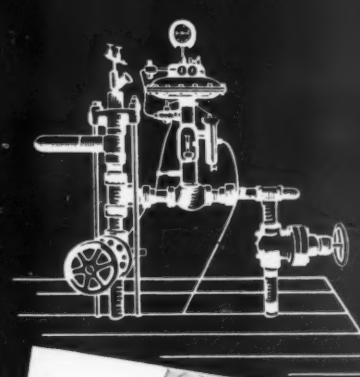

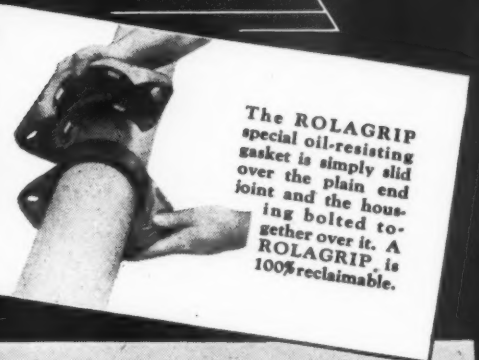

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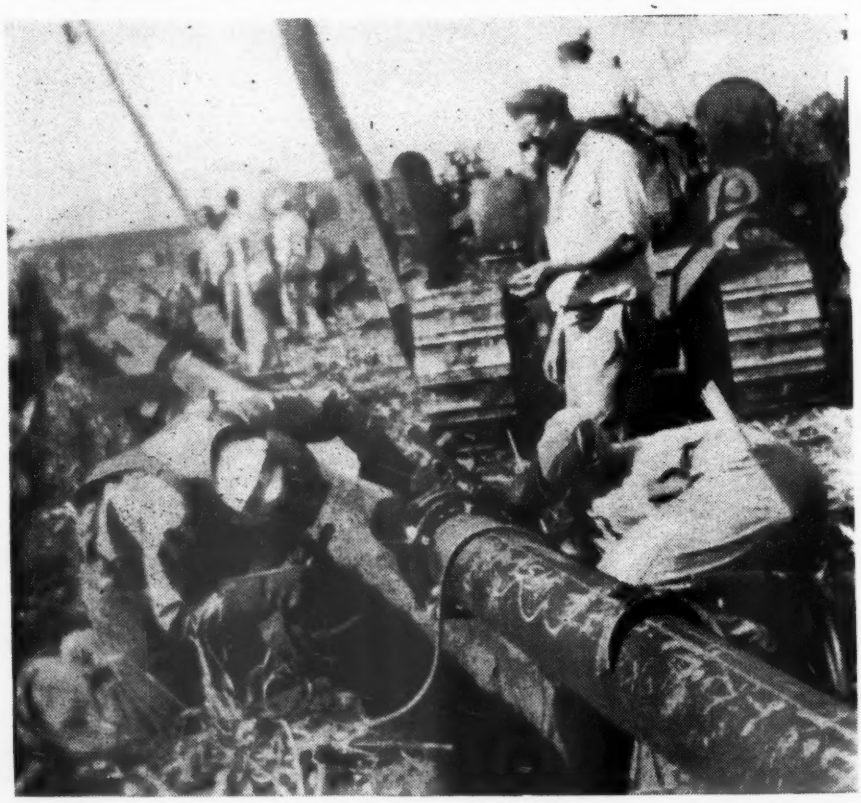
Pipe welding for Mississippi River crossing, above, on Standard of Indiana's products line. Two welders, below, make simultaneous stringer beads on an 8-in. line for the Great Lakes Pipe Line Company.



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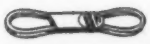

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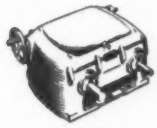

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1847 1947 A CENTURY OF SERVICE to Industry THAT MADE America Great

Final main line weld on the Southern Natural Gas Company's expansion project.

Welding an 8-in. line for the Great Lakes Pipe Line Company. Welder has protective windguard.

scale is then removed from the pipe. To insure cleanliness of the faulty portion of the line it is often washed with gasoline after the rust and scale have been removed. The pit holes and corroded areas are checked (using a pointed hammer) and marked. If they are found to be greater than 10 to 15 per cent of the wall thickness in depth they are repaired by depositing a filler of ¼-in. mild steel electrode, or, if overhead welding is employed, by depositing a filler of 3/16-in. mild steel electrode.

Almost 4000 miles of pipe line were under construction last year. Of this total, nearly 3000 miles were completed and put into service, with lines varying from 8 to 12 in. in diam, and varying in length from 70 to 1000 miles. The remaining lines will be put into immediate service as soon as they are completed.

TABLE 2. Recommended amperage for various sizes of rod.

Roll welding.

Size rod, in.	Amperage
1/8	100–150
5/32	125–200
3/16	150–225
7/32	175–300
1/4	200–325
5/16	250–400
3/8	350–500

Position welding.

1/8	100–150
5/32	125–200
3/16	125–200

The Great Lakes Pipe Line Company links Barnsdall, Oklahoma, Alexandria, Minnesota, Grand Forks, North Dakota, Marshall, Minnesota, Watertown, South Dakota, Mason City, Iowa, and Mankato, Minnesota, in its new projects that total more than 1000 miles.

The Socony-Vacuum Oil Company has under construction an 8, 10, and 12-in. line of 300 miles that will tie together Paulsboro, New Jersey, and Midland, Pennsylvania. The Sinclair Refining Company is linking Toledo with Detroit and Columbus, and Cleveland with Marion and Steubenville. These are 6-in. high-pressure lines that Sinclair plans to put into service on the date of completion.

The Standard Oil Company of Indiana has built 6 and 8-in. lines between Whiting, Indiana, and Moorehead, Minnesota, covering 662 miles.

The Wood River Oil and Refining Company is constructing an 8-in. line between Peru, Illinois, and Rockford, Illinois, covering a distance of more than 70 miles, and the Humble Pipe Line Company has linked Baytown and Irving, Texas, with 276 miles of 8-in. products line.

The accompanying photographs show arc-welding operations on recent pipeline projects that were completed and put into immediate service by the Standard Oil Company of Indiana, Great Lakes Pipe Line Company, and the Southern Natural Gas Company.

A "grasshopper" or line-up clamp is sometimes used during aligning and tack welding, but in the case of large diameter pipe an inside line-up clamp is employed. This device is expanded hydraulically inside the joint, permitting the welders to start the finish welds without tacking. These clamps are easily assembled and taken down and moved to the next joint in minimum time.

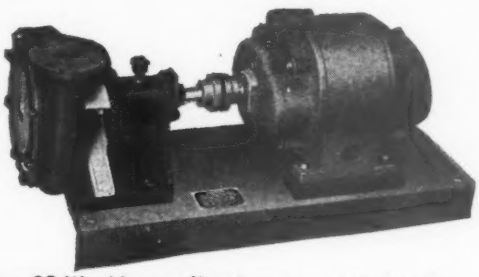
In river crossings, the wall thickness of the line should be at least 50 to 100 per cent greater than the rest of the line. The pipe is roll-welded or, sometimes, bell-hole welded, into a section long enough to facilitate the crossing, with each joint reinforced and anchored by a sleeve that is welded on. The pipe is further strengthened and anchored by special river clamps that weigh from 1000 to 3000 lb each. These clamps are bolted on at intervals of approximately 10 ft. The pipe is then snaked over pontoons across the river and dropped in a river bottom ditch that has been dredged to a depth of no less than 8 ft.

The recommended sizes of electrodes for pipe-line welding are contained in Table 1. Table 2 gives the recommended amperage for various sizes of rod.

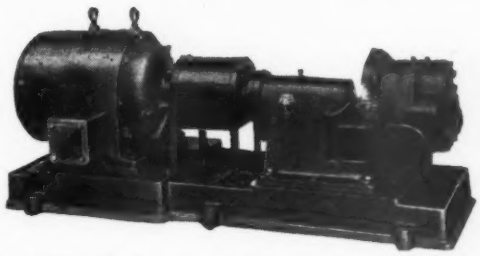
Information received from pipe-line contractors this year indicates that no new techniques have been put into effect on the construction and repair of lines; however, since many lines have been in constant use for many years, the repair and maintenance of these lines is sure to bring about new "kinks" and "gimmicks" through the advancement of procedures and development of equipment.

★★★

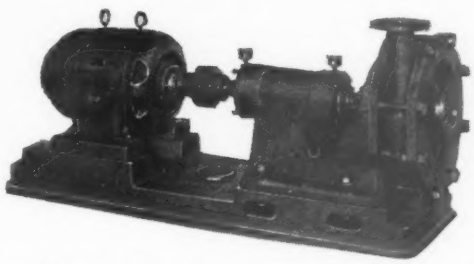
PUMPING CORROSIVE LIQUIDS



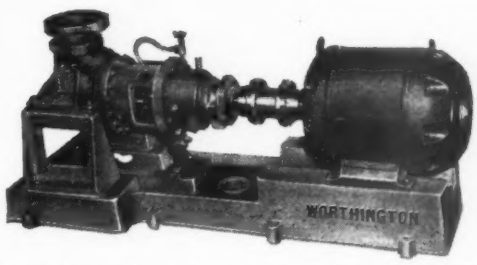
Type CG Worthite centrifugal pump.. open impeller... capacities to 3000 GPM . . . heads to 150 ft.



Type HBLC Worthite centrifugal pump . . . vertically split . . . capacities to 240 GPM . . . heads to 540 ft.



Type CQ Worthite centrifugal general-purpose pump . . . capacities to 600 GPM . . . heads to 130 ft.



Type HR centrifugal pump . . . capacities to 1800 GPM . . . heads to 900 ft. . . . temperatures to 800°F. . . . pressures to 750 PSI.

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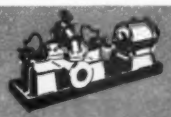
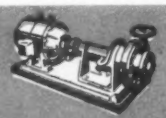
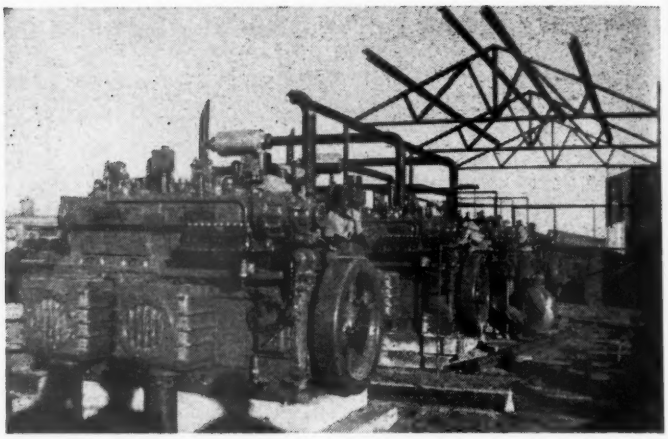


Type LT. Nine sizes. Capacities to 2500 g.p.m. Developed heads to 900 ft. Horizontally split case for temperatures up to 600°F. and pressures to 400 p.s.i.



Type HL. Several construction arrangements permit flexibility in application. Designed for temperatures up to 225°F., or higher with water-jacketed stuffing box. Capacities up to 1600 g.p.m., heads to 500 ft.

Field compressor stations



By **C. S. WORLEY**, *Engineer*,
Consolidated Gas Utilities Corp.

EXCLUSIVE

With the ever-expanding demand for natural gas, it is becoming increasingly desirable to recover as nearly 100 per cent from the producing formation as may be done economically. It is just as wasteful to allow the gas to remain in the bowels of the earth as to permit it to blow into the air.

Many oil fields, where the pressure has been reduced to only a few pounds over a period of years, still supply the needs of local communities, and constant service is maintained through the operation of one or more field compressor stations. These stations usually consist of old type compressor units and the operating efficiency is universally low.

New major gas fields are not being discovered and developed as rapidly as the demand is increasing in some areas, where production may soon be less than actual needs. Field prices are advancing materially in some areas, and this increase will perhaps become general. With the increased value of gas in the field, and with the enormous investment in production facilities and in transmission lines and equipment, a company will not, in the future, be disposed to abandon a major section of its system so long as its lines can be maintained near capacity. This can be accomplished only through the installation of field compressor stations, and in many areas the well pressures can be economically reduced to near zero before a field is finally abandoned.

Field stations are required only when the well pressures are not sufficient to feed adequately into the transmission lines, and with the tendency toward much higher working pressures on cross-country lines, the need for increased pressures throughout the system is apparent.

In deep gas fields the original pressures are almost universally high, and reducing valves are sometimes required, but it is only a matter of time, in any gas field, until field stations become necessary if any great volume is to be introduced into the transmission system.

Many types of compressor units are used in this service, the most common, perhaps, being the slow-speed, horizontal, direct gas-engine-driven compressors. These are economical and dependable, but usually rather inefficient.

Numerous belted compressors, driven by high-speed multi-cylinder engines are used on small-volume wells. These have their place in the overall picture and require little attention.

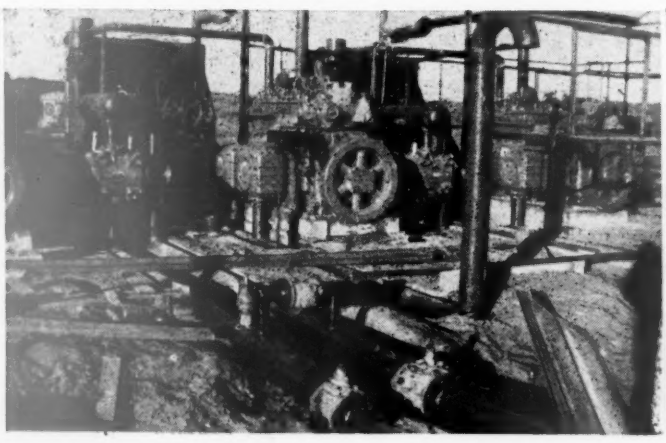
In cases where a low differential pressure and substantial volume is required, rotary or blower-type compressors seem to be doing a satisfactory job, and some definite progress seems to have been made in the perfection of a gas-fired, turbine-type unit.

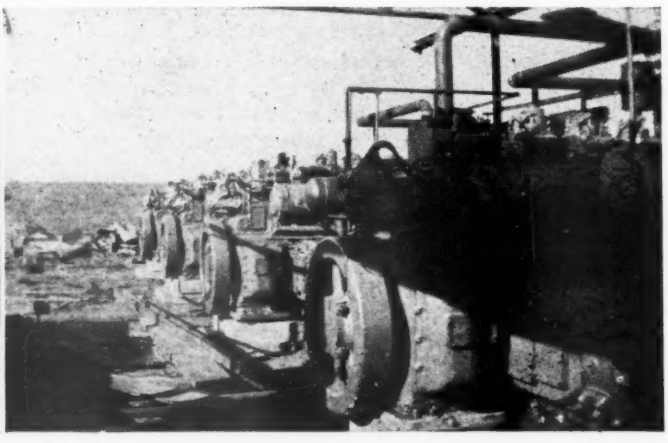
The definite trend, however, seems to favor a comparatively small, compensating, piston-type, medium-speed compressor, direct connected to a multi-cylinder gas engine. Several of the major manufacturing companies are in production on these units, which range from 75 to 225 hp, and are semi-portable. Many are being provided with radiator-type coolers, and assembled with automatic controls that make their operation practically automatic.

Particularly in the Texas Panhandle field, where the well pressures have been reduced to a point where they will no longer feed into the transmission lines, numerous such installations are currently being made.

The design of a transmission line compressor station is a comparatively simple matter by the predetermination of intake and discharge pressures, and spacing of the stations along the transmission line. This is not such a simple problem, however, in the case of field stations. Operating conditions change continuously because well pressures are constantly declining. A given sized cylin-

The pictures on this page show views of a typical field compressor station in process of construction. (Photos courtesy Frenchie's Construction Company, Shamrock, Texas.)





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der, designed for full load under the original pressure conditions, will soon be out of proportion with the reduced intake pressure, provided the discharge is to remain constant. It is, therefore, desirable to select cylinder sizes to accommodate the early operating conditions, but to provide them with adjustable clearance valves and pockets. In this way, reasonable efficiency can be expected over a relatively wide range of pressure conditions.

The proper location of field compressor stations is a very important consideration. As approximately four times the volume of gas will pass through a given sized line at 300 psi intake as it will carry at 75 psi inlet, with the same pressure drop, it is most advantageous to place field stations as near individual wells as possible. This often means that many stations will be required in a given field, each connected to a small group of wells, even though the discharge lines may extend a much greater distance to the transmission line, or to a central field compressor station. In other words, gas can be *pushed* much cheaper than it can be *pulled*.

In using the newer type compressors, many operating problems are being simplified. One big advantage is the closed-type water and oil cooling system. A quantity of suitable jacket water is often impossible to procure in sufficient quantities for the open-type coolers where water losses are excessive. In the closed-type coolers, the amount needed is reduced to a minimum, and the quantity needed for make-up is negligible.

Another feature on some of the newer units is the diverting of a small portion of oil from the pump pressure line, through a filter, and into the lubricator, with an overflow connection near the top of the lubricator reservoir leading back into the crankcase. This arrangement insures a full lubricator of clean oil at all times.

With an over-speed shut down device, and the same protection against excessive jacket water temperature and oil pressure failure, and with a full lubricator at all times, these new units are practically automatic. Instead of requiring a complete operating crew for each station, one or two men can care for several such stations properly by making an inspection of each station once or twice each day.

These are semi-portable units. Some are completely skid-mounted, others set on light concrete foundations. The construction costs are relatively low, ranging in costs from $125 to $160 per hp, depending on local conditions and the amount of refinement employed in the construction and finish of the individual station.

In areas where the purchase price of gas is low, and particularly where an operating company has its own production and the principal initial cost is the payment of royalty, the field cost can still be maintained at a very low figure after providing for ample field compressor station equipment, in most gas producing areas. ★ ★ ★

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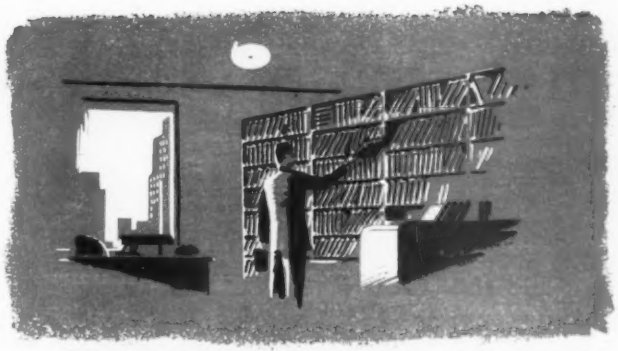

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OFFICIAL SOURCE OF INFORMATION FOR THE WORLD'S OIL AND GAS INDUSTRY

Dust scrubber research yields valuable data

By HAROLD F. DAWE[1] and J. E. STEPANEK[2]

DUST removal units for natural gas pipe-line service usually consist of a vertical cylindrical shell containing in the lower part an arrangment for thoroughly contacting the incoming gas stream with a light scrubbing oil, and in the upper part an air baffling apparatus for removing from the gas the oil mist created by the action of the oil contacting the section below it. These units have been built to remarkable efficiencies by the use of special equipment to effect exceptionally intimate contact between the gas and the scrubbing oil, and efficient scrubbers for removing all traces of the oil mist from the outgoing gas.

EXCLUSIVE

[1]Engineer, Stearns-Roger Manufacturing Company.
[2]Assistant professor, University of Colorado, Department of Chemical Engineering.

The scrubbers customarily are fitted with a special drain, centered near the bottom head, which is used to blow out normal accumulations of dirt in the scrubber base. The scrubber is also equipped with large cleanout manholes in the base through which may be removed accumulations of heavy material too large to be blown out through the drain.

The general arrangement of a dust scrubber is shown in Fig. 1. The inlet gas enters the shell through the lower inlet nozzle. Its impact is broken up by a baffle and the large particles of dirt, scale, weld metal, etc., simply fall by gravity into the oil pool in the lower part of the shell. Immediately above the gas inlet nozzle a transverse plate divides the shell into halves. This plate carries a number of tubes that hang down from it. These tubes are open at both ends. In some designs the bottom ends of the tubes are staggered; in some the lower ends are all the same length.

The level of the scrubber oil is maintained by manual adjustment so that in operation it is an inch or two below the bottom ends of the tubes.

Usually the scrubbers are placed in batteries so that one or more units are always in operation while one unit may be shut down for cleaning. Where a battery of units is installed it is important that the flow of gas through each unit be uniform. To accomplish this, it is common to install a manometer across the inlet and outlet of the scrubber. The manometer of each scrubber in the battery is adjusted to the same differential when it is considered that the flow is essentially uniform. In other cases, an orifice plate is installed in the outlet line from the scrubber and a flow meter or manometer installed. The scrubbers are balanced through these to adjust the flow uniformly.

In order to introduce scrubber oil into the scrubber while the unit is under pressure, it is usual to provide an equalizing tank to charge the oil, or in other cases, to use a high pressure pump of small capacity.

The Stearns-Roger Manufacturing Company was called upon late in 1943 to provide dust scrubbers for use in the Tennessee Gas and Transmission Com-

FIG. 1. General arrangement of dust scrubber.

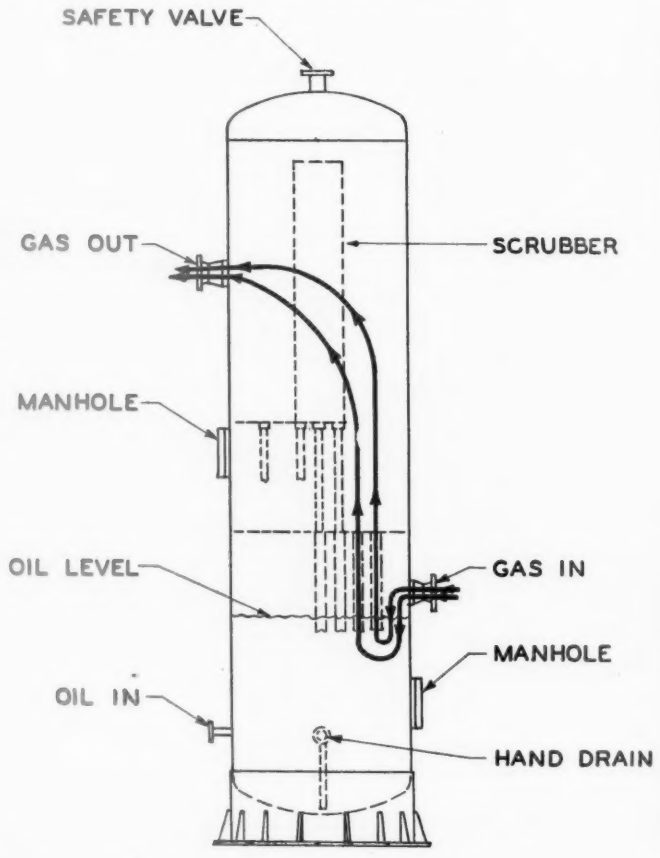
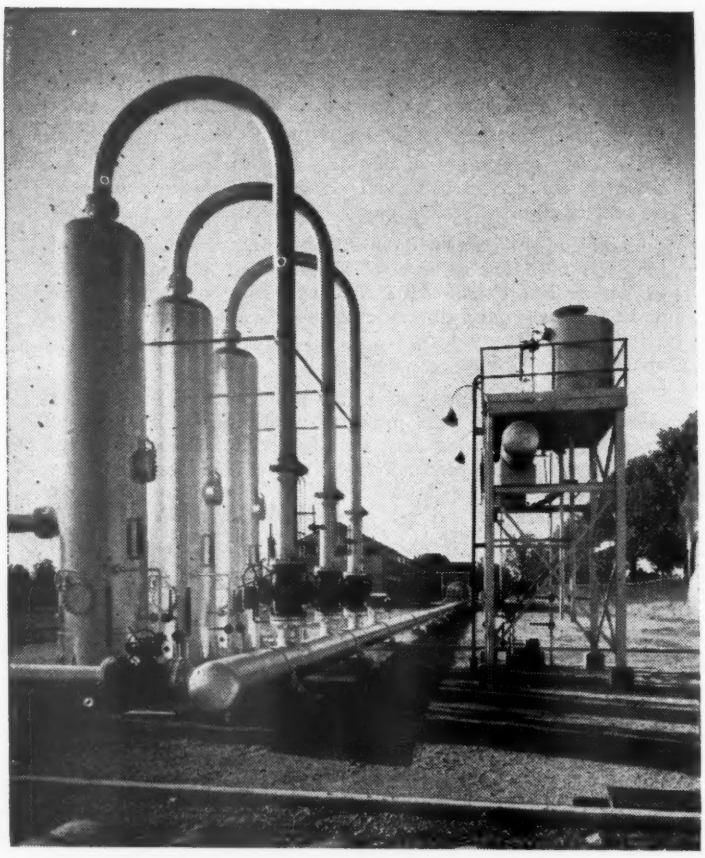


FIG. 2. Typical initial installation.



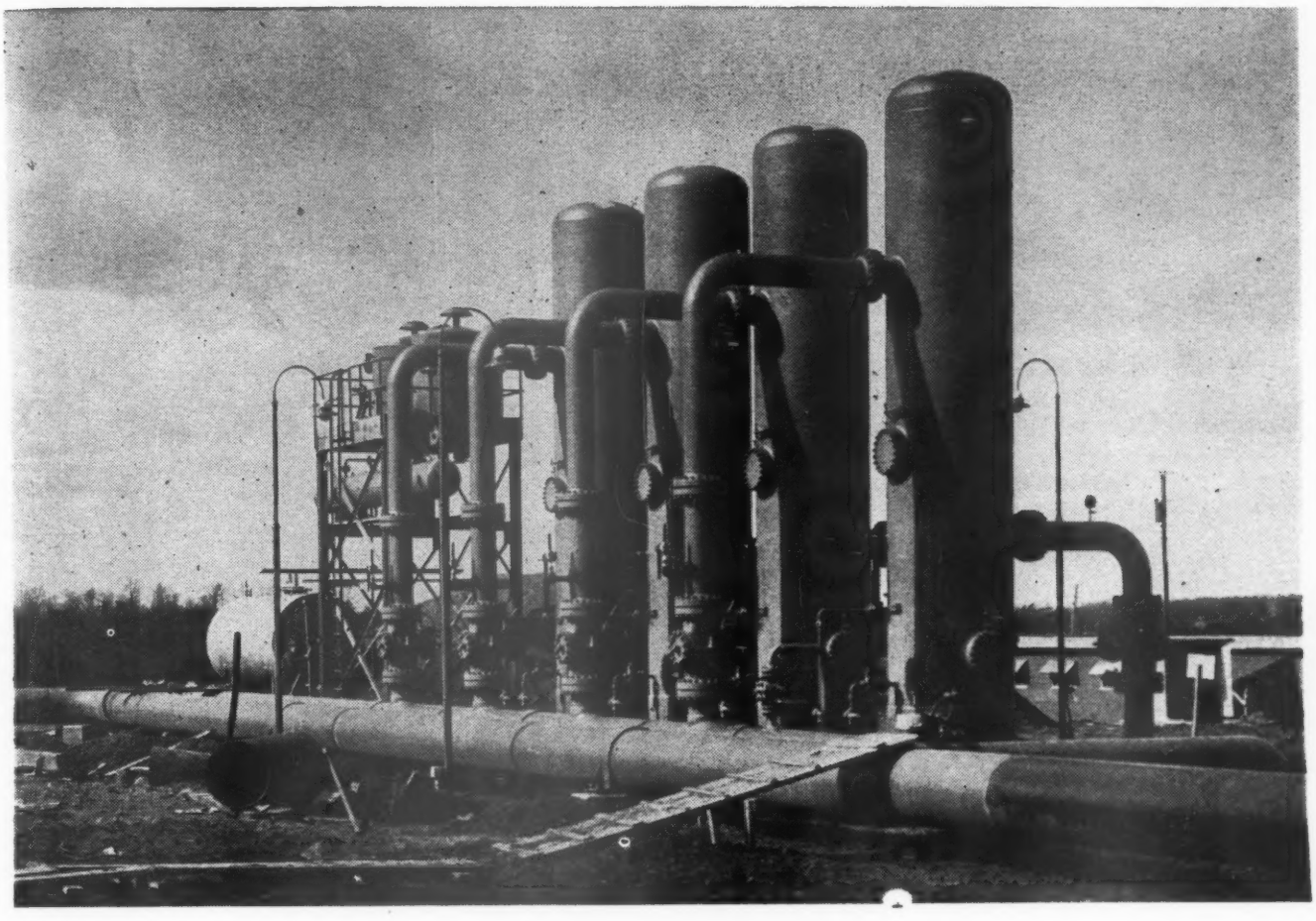


FIG. 3. Above, later installation with outlet gas lines from side of shell.

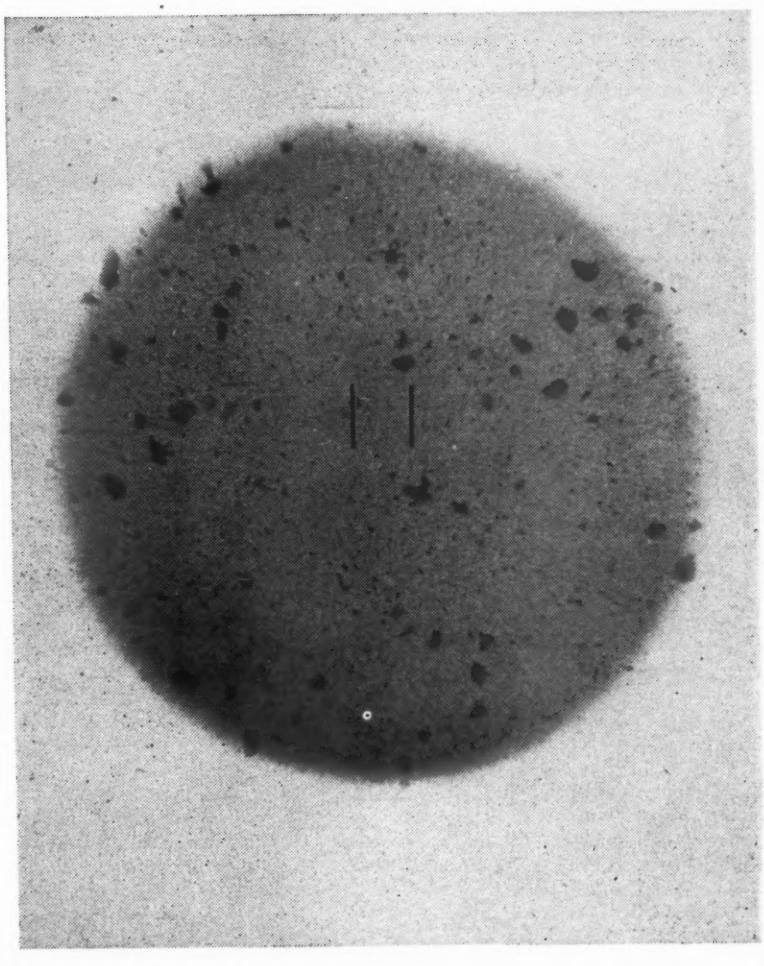


FIG. 4. Right, photomicrograph of pipe line dust particles (reference lines are spaced at 50 microns).

pany's 24-in. line from Agua Dulce, Texas, to Kenova, West Virginia. Little design data were available and less was known in regard to the efficiency of the various available scrubbers. Many designs were considered. As there was no time to undertake a research and testing program it was necessary to design these units with the information available. For the above outlined service a vertical type scrubber was designed having a shell divided into halves by a transverse plate that supported tubes extending down slightly below the oil level. The bottom ends of these tubes were slotted to induce a spray action for wetting the dust in the gas. Adequate space was provided in the base for dust to accumulate. In the top half was installed a standard Mist-D-Fier scrubber to remove all traces of oil mist created by the oil contacting section. An arrangement for metering the flow of gas through each scrubber was provided. The original units were installed in batteries of three, each unit handling about 75,000,000 cu ft a day.

A conventional pressure charging tank was used, and an arrangement of tanks for settling the dirt from the oil blown

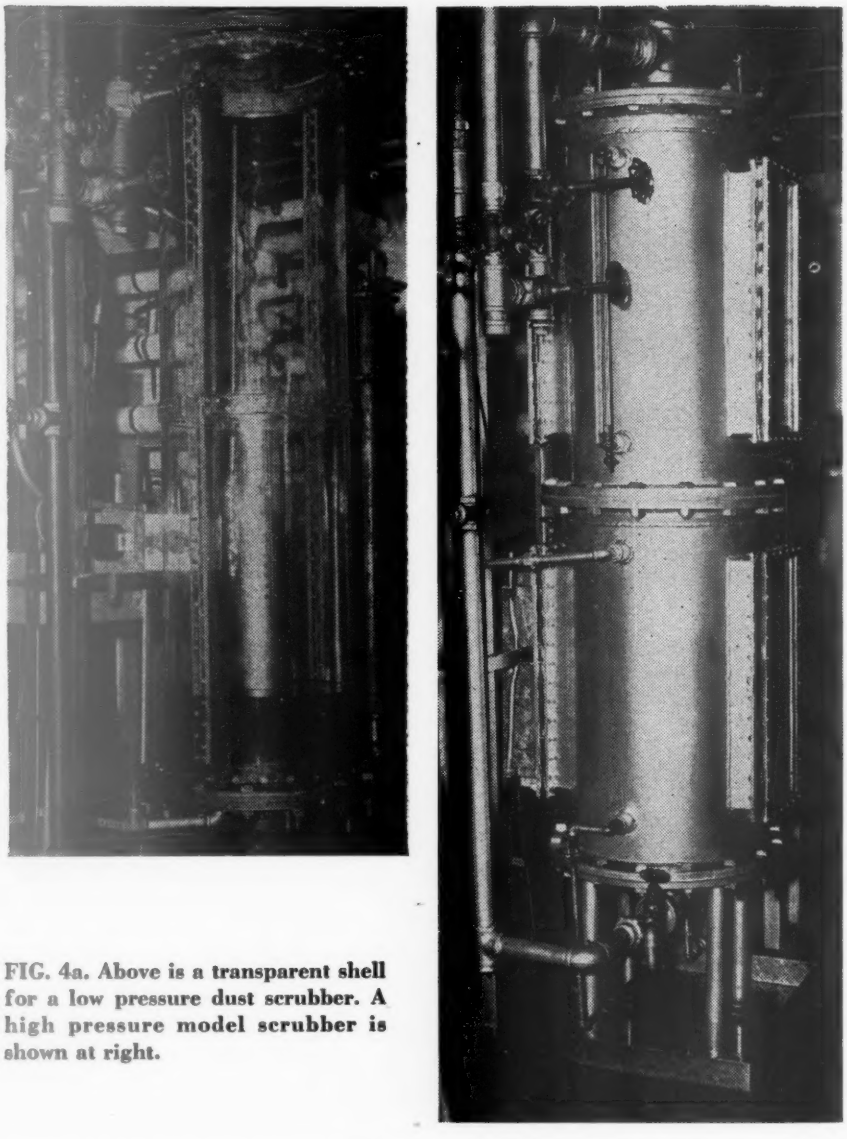


FIG. 4a. Above is a transparent shell for a low pressure dust scrubber. A high pressure model scrubber is shown at right.

from the base drain was provided. These units were very efficient in the removal of all dirt from the gas and after proper adjustment were not critical as to gas flow.

Fig. 2 shows a typical initial installation with the pertinent apparatus. Fig. 3 shows a later installation with the oulet gas lines from the side of the shell. This arrangement has proved to be more satisfactory as it was found to be more rigid and less expensive.

● **Research program.** Subsequent to the mentioned installations, a program of research was adopted to determine the exact characteristics of the scrubbing mechanism and the relative efficiencies. Even though the natural gas industry has long recognized the importance of dust removal in long distance transmission very little attempt has been made to study scientifically the operation of dust scrubbers. It is known that any dust carried along by the gas stream will have an abrasive action on the walls of compressor cylinders. Hence it is essential that virtually all dust be removed at the inlet side of each compressor to minimize the charges for compressor maintenance.

New transmission lines contaminate the gas with mill scale plus any soil constituents picked up during construction. No amount of "blowing" prior to placing the line in operation will remove all the dust. In fact, the gas will continue to pick up dust from the pipe walls during many years of operation. Gas passing through lines that have been transformed from oil to gas service would contain rust plus solid hydrocarbon condensation products.

● **Pipe-line dust analyses.** Before attempting to study the mechanics of removing dust from natural gas it was considered of primary importance that the properties of pipe-line dust be determined. Two dust samples were procured for complete analysis. The first sample was obtained during November, 1946, from a dust scrubber at the Campbellsville station of the Tennessee Gas and Transmission Company. The second sample came from the Hope Natural Gas Company's Cornwell station.

Table 1 presents screen analysis data for the two samples. The 325-mesh particles from the Tennessee Gas and Transmission Company line sample were examined further with a 500-power microscope. It was estimated that 95 per cent of the particles in this fraction were less than 3 microns in diameter and that a substantial number were of the order of one-tenth micron. Fig. 4 shows abraded transparent crystals that have been identified as silica using a petrographic microscope. The results of a chemical analysis have been presented in Table 2.

The dust may be characterized as consisting almost entirely of inorganic matter—most likely iron, iron oxide, and silica or silicates. The small average particle diameter testifies to a long period of attrition against the pipe wall. The Hope line produced a much finer dust than the newer Tennessee Gas and Transmission Company line. The diameter of the smallest particles indicates the need for a highly efficient dust scrubber. The chemical analysis suggests that the sample from the newer line contained more free iron and less of the oxide.

● **Design of the model dust scrubber.** Having a knowledge of the properties of the dust it was possible to consider suitable methods of removal. Because of packing difficulties under high pressure and maintenance expense, it was considered undesirable to use any rotating or moving parts within the scrubber. The size of the smaller particles eliminated any consideration of a centrifugal type separator. The relatively low gas velocities required for electrostatic precipitation would have required large units with a resulting high expense for pressure equipment. The final decision was to contact the gas intimately with a liquid and then to remove the dust from the liquid by filtration. Water is not a desirable scrubbing agent, particularly where the natural gas has been dehydrated to reduce the dewpoint. A light mineral oil was selected as the best scrubbing medium under the conditions.

The oil used in all the tests was a Continental Oil Company diesel fuel having the following properties:

ASTM initial boiling point	430F
ASTM end point	587F
API gravity	38.4

In designing the shell of the model unit it was necessary to make provision for observing the scrubbing mechanism. The first experimental unit was contain-

TABLE 1
Screen analysis of dust samples.

Tyler standard screen	Sample per cent by weight passing the given mesh size	
	TG & T sample	Hope Natural Gas sample
10	0.34	1.00
20	1.16	2.07
28	1.81	8.01
35	1.01	..
40	3.22	..
48	8.64	2.00
60	8.41	..
65	2.19	5.69
100	8.77	11.55
150	45.75	24.20
200	12.63	21.20
325	5.97	24.28
	100.00	100.00

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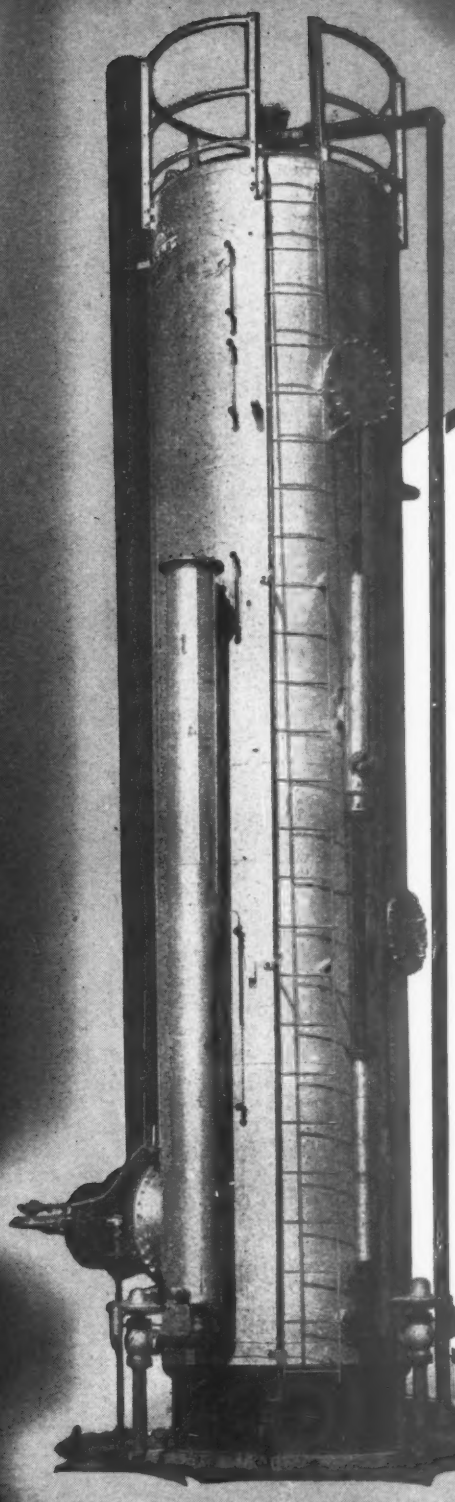

Here, in one complete, self-contained unit is the device that effectively separates well production into dry gas, oil-free water, and clean oil. This new Black, Sivalls & Bryson Type "F" Stage Treater has these definite advantages over previous types of emulsion treaters:

- **Quiet, Gas-Free Settling Section.**
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- **Two-Stage Free Water Knockout** – prevents drawing oil through water siphon and its loss in your disposal pit.
- **Single Outside Adjustable Water Siphon**—simplifies pipe hook-ups...makes the adjusting of the oil-water interface easy.
- **Gravity Loss Prevented by Treating Cycle** – condenses vapors driven from heated oil . . . stabilizes crude with its continuous condensing and vaporizing cycle.
- **High Gas Separating Capacity**—entire diameter of treater serves as a separator.
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These vital improvements can be of great aid to you in solving your production problems. Call in your nearest B, S & B man, or write Executive Offices, Black, Sivalls & Bryson, Power and Light Building, Kansas City 6, Mo., for new detailed booklet.

12

EFFICIENCY

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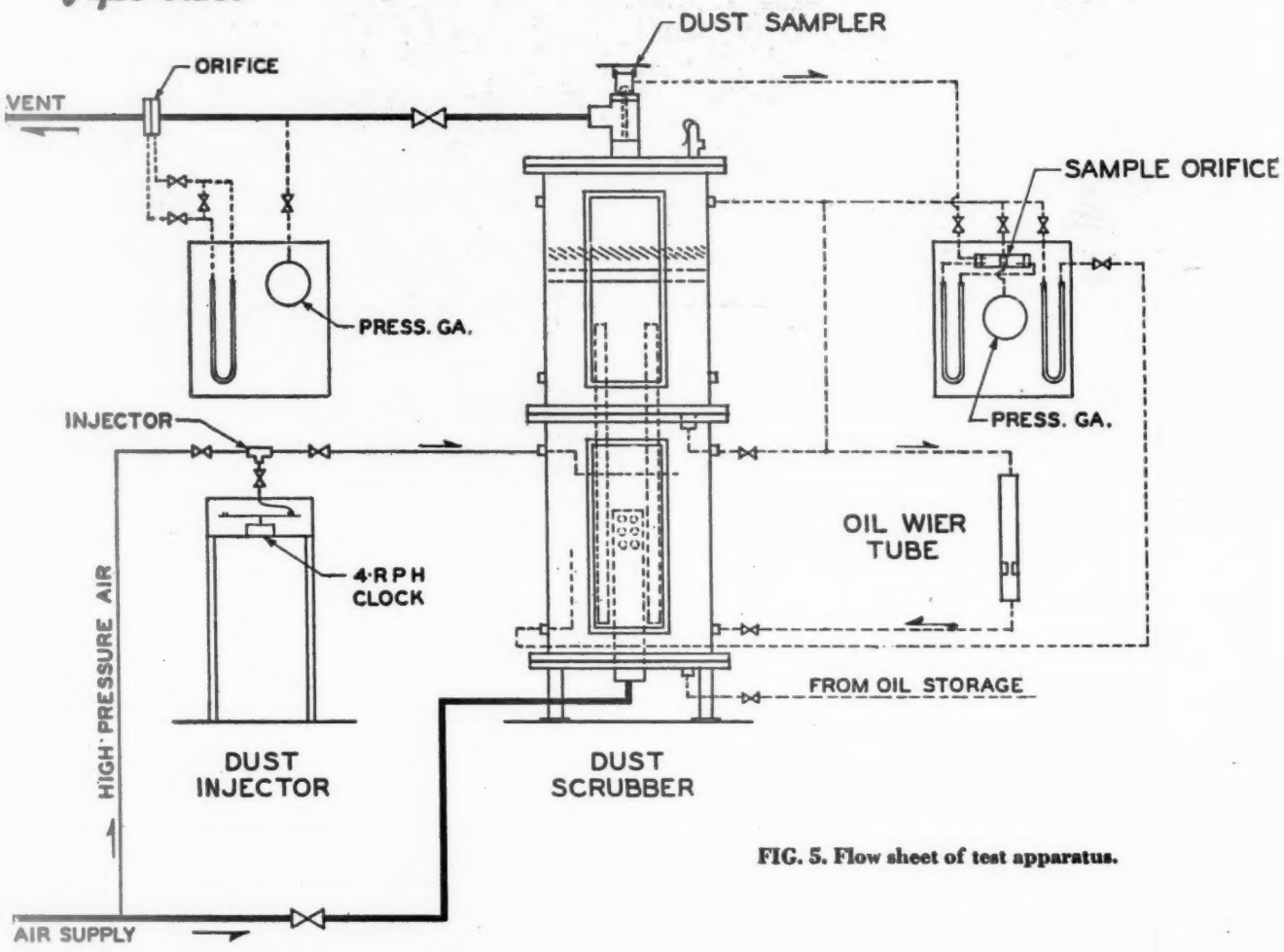

FIG. 5. Flow sheet of test apparatus.

ed in a transparent plastic shell, 19 in. in diam by 72 in. high, fabricated of ¼-in. Lucite sheeting. To allow for higher operating pressures a second unit was constructed in a steel shell having four plate glass windows, each 8 in. by 24 in. These units are illustrated in Fig. 4a.

The dust scrubber itself consisted essentially of a single, vertical, transparent tube with one end at or near the oil surface and the other projected through a tube sheet into the oil removal section. As the gas passed through the orifice formed by the end of the tube and the oil surface, a spray was formed that remained in intimate contact with the gas as it traveled up the tube. A scrubbing biscuit was used to remove the oil droplets. The oil flow was regulated by returning the oil from the upper section externally through a control valve and a calibrated orifice. The details of the assembled test unit are presented in Fig. 5.

It was necessary to design a constant rate dust feeder and to perfect a method for measuring the amount of dust in the processed gas in order to determine the dust removal efficiency. The dust to be added was placed on a plate in a circular groove, which was rotated in a horizontal plane by a clock motor. An aspirator system injected the dust into the main gas stream as it entered the scrubbing element. The rate for all tests was maintained constant at 40 grams of dust per hour irrespective of the gas flow.

The dust in the exit gas was detected by a modified form of the apparatus recommended by the American Society of Heating and Ventilating Engineers in its test code for air cleaning devices. As the gas left the top of the scrubber a small side stream was filtered through an alundum crucible. Although the crucible was in an inverted position, tests showed that all the dust particles adhered to the surface. The weight increase of the crucible for a known gas flow gave a measure of the dust not being removed.

A representative gas sample was assured by removing the sample stream through a pitot tube at a velocity equal to that of the main stream.

The flow of exit gas was measured through an ASA 300 orifice flange union in a 1½-in. line. Although natural gas would have been preferable, air was used because of its availability.

As it was desirable to test the scrubber under the most severe conditions, a dust was used of lower density and even smaller average particle size than that recorded for pipe-line dust. Experiments were conducted with iron powder, rouge, lampblack, powdered graphite, and finely ground bituminous coal. It was found that the bituminous coal best served the purpose of the tests. The test dust was prepared by drying and removing all material that would not pass a Tyler 325 mesh screen. By using a 250-power microscope, a drawing camera, and a calibrated slide it was possible to estimate the size range of the particles as follows:

Diameter range in microns	Per cent by number of particles
43 to 25	2
25 to 10	4
10 to 5	10
5 to 1	14
1 to —	70
	100

TABLE 2
Chemical analysis of dust samples.

Sample	Tennessee Gas and Transmission Company sample			Hope Natural Gas sample		
Tyler screen range	28-35	60-65	150-200	28 48	100-150	200-325
Per cent iron (free and combined)	52 9	76 5	63 8	52 0	55 5	53 2
Per cent moisture and volatile matter	0 5	2 6	4.4	6.8	4.5	5.6

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TABLE 3. Dust removal efficiency tests.

Test no.	Gas flow rate, cfm	Gas flow rate, lb per min	Dust concentration, grains per 1000 cu ft		Dust removal, efficiency, per cent
			Inlet gas	Outlet gas	
Tube I—Plain end					
76	18.0	1.8	570	3.0	99.47
75	17.1	4.6	600	2.5	99.58
74	32.2	1.8	320	2.6	99.19
73	30.9	4.6	330	1.1	99.67
Tube II—Vertical slots					
77	17.9	1.8	575	2.0	99.65
80	17.0	4.6	605	1.9	99.69
79	31.2	1.8	330	1.6	99.51
Tube III—Vertical staggered slots					
57	18.6	1.8	555	2.9	99.48
56	17.4	4.6	590	2.3	99.61
59	18.3	4.6	565	2.0	99.65
61	28.0	4.6	370	1.1	99 70
63	31.2	1.8	330	3.3	99.00
62	32.5	4.6	315	1.5	99.52
Tube IV—Vertical tangential slots					
70	18.3	1.8	565	3.1	99.45
65	18.4	4.6	560	1.5	99.73
69	33.0	1.8	310	2.2	99.29
68	34.4	4.6	300	1.2	99.60

The dust concentration was kept to a minimum by allowing the oil to settle in a separate container between tests.

Preliminary tests showed that the scrubbing efficiency and the pressure drop were affected by the oil rate, the type of slotting used at the lower end of the tube, and the tube diameter as well as by the gas flow rate.

● **Test procedure and results.** It was realized that it would be undesirable to try exactly to duplicate pipe-line conditions in the model scrubber. The maximum allowable pressure was only 50 psig in the model unit, only one tube instead of a bank was tested at any one time, and air was substituted for natural gas. Despite these obvious limitations, the apparatus was believed capable of yielding data on the relative effect on the dust removal efficiency of changing the operating variables. The optimum operating conditions for the model unit apply in general to an industrial scrubber.

Numerous tubes of varying diameter and type of slotting were tested. Each series of tests included 30 minute runs at varying oil and air flow rates. A record was kept of the pressure drop, the weight of dust picked up by the filtering crucible, and notes were taken on the scrubbing action. Great care was taken in standardizing the procedure so that test results could be duplicated. With experience, it was found possible to measure the dust content of the exit air with a probable error of 10 per cent.

The air temperature was held in the range from 60 to 70 F while the pressure was varied from atmospheric to 30 psia.

The first tests were made to observe visually the mechanism by which the oil contacted the air. It was found that the kinetic energy increase of the air as it passed through the slots above the liquid surface was balanced by a decrease in pressure, which could be measured by noting the rise of the oil level within the tube. As the air flow rate was increased, a point was reached at which the oil was picked up by the air to form a spray. With symmetrical slotting the oil spray tended to be the heaviest at the center of the tube. The turbulence within the tube, however, was sufficient to distribute the spray evenly by the time it had been carried about 1 ft up the tube. Any spray that hit the tube wall formed a stream of recycle oil.

These tests emphasized the need for independent control of the oil flow rate to insure adequate scrubbing action for all rates of air flow. In all subsequent tests the amount of oil leaving the upper end of the tube was carefully controlled and measured.

In Table 3 test data have been reported for four different types of tubes. All were 46 in. long, and were fabricated from transparent plastic tubing having a 2-in. OD and a 1/10-in. wall. The slotting dimensions were as follows:

Tube I —Plain end, no slotting.

Tube II —12 vertical slots, evenly spaced, each ¼ in. wide by 6 in. high.

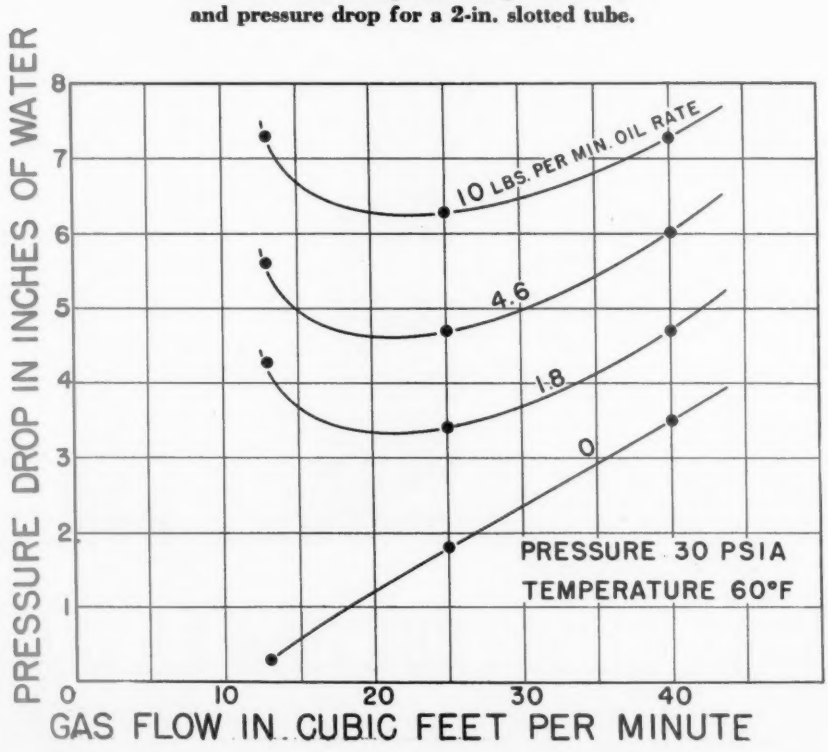
Tube III—12 vertical slots, evenly spaced, with the tops staggered by 1-in. increments. Each slot ¼ in. wide and from 3½ to 8½ in. high.

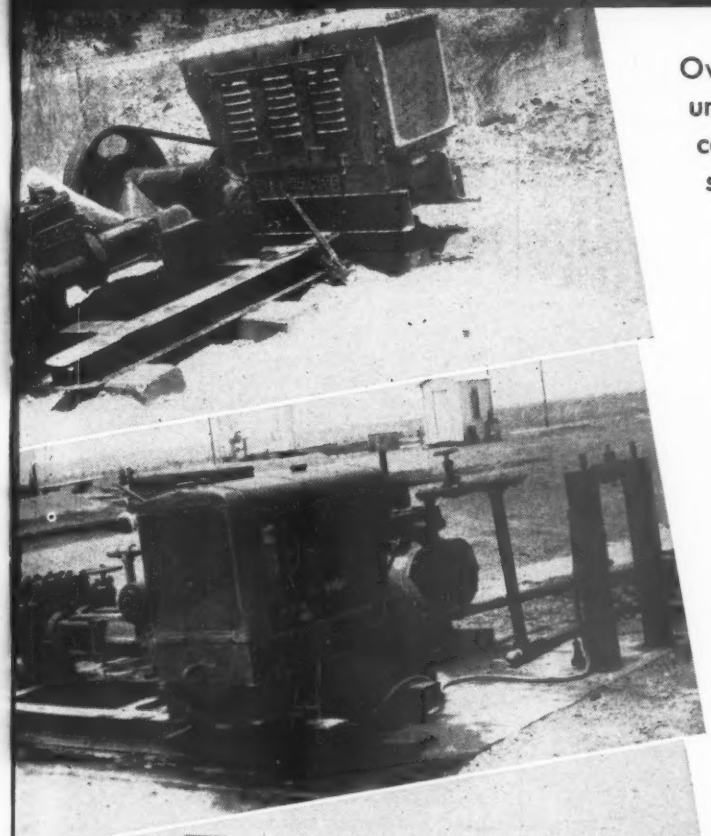
Tube IV—12 vertical slots evenly spaced as in Tube II except that the centerline of each slot was displaced ½ in. from the centerline of the tube.

The air flow rate was measured under test operating conditions that averaged 24 psia pressure and a temperature of 60 F.

It had been expected that by changing the slotting the degree of contact between the gas and oil would be affected with a resulting change in the efficiency; however, the test data indicate an extremely high efficiency for all tubes with no significant differences. With an increased gas flow rate or a decreased oil rate efficiency was materially lowered.

FIG. 6. Relationship between gas flow rate and pressure drop for a 2-in. slotted tube.





Overpowering an installation can be as inefficient and uneconomical as underpowering. An engine of proper capacity and one that is designed for the particular type service will be the most economical.

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The efficiency is truly remarkable when it is realized that the dust concentration in the treated air is so low that it represents about 1 lb of dust per 300,000,000 cu ft per day of natural gas passed through a commercial scrubbing unit.

● **Pressure loss tests.** A knowledge of the amount of energy required to force the air through the scrubber was equally as important as the dust removal efficiency. The pressure loss for all tubes was determined as a function of air and oil flow rates at various pressures. The results of one such series for a 2-in. slotted tube are presented in Table 4. All 12 tests were performed with the air at 60 F and a pressure of 30 psia.

The unpredicted relationship between air flow rate and pressure drop can be best seen in Fig. 6 where the pressure drop was found to decrease to a minimum value for an increasing flow rate. This anomaly can be partially explained by the fact that for a lowered gas rate the energy expenditure per pound would have to be higher to lift a given weight of oil. A simple calculation shows, however, that this effect must be slight. In Test 4 only 12 per cent of the energy lost by the air was used in lifting the oil at the rate of 10 lb per min.

A better hypothesis can be based upon the effect of the recycle oil. At low air flow rates, the oil recycle rate is high with a correspondingly high pressure drop. As the air flow rate increases, less oil can remain in the tube with a resulting decrease in pressure loss. At the same time another pressure loss factor—that of the flow friction loss of the gas passing through the orifice—is beginning to take effect. As the flow increases this factor begins to counterbalance the oil recycle effect until a minimum pressure loss point is reached. Visual observations made during the tests substantiated this theory. So far it has not been possible to express the relationship between the flow variables mathematically. With more data this may be possible.

TABLE 4
Pressure drop tests on a 2-in. slotted tube.

Test no.	Gas flow rate, cfm	Oil flow rate, lb per min	Pressure loss, inches of water
1	13	0.0	0.3
2	13	1.8	4.3
3	13	4.6	5.6
4	13	10.0	7.3
5	25	0.0	1.8
6	25	1.8	3.4
7	25	4.6	4.7
8	25	10.0	6.3
9	40	0.0	3.5
10	40	1.8	4.7
11	40	4.6	6.0
12	40	10.0	7.3

● **Summary.** A large portion of the time spent to date on this research program has had to do with perfecting the means of adding and detecting the dust. The final design is believed to be both simple and accurate. An oil flow rate controlled independently of the air flow rate was found to be essential to high removal efficiency. Through such a design the efficiency was found to increase rather than decrease at low flow rates. When operating at the point of minimum pressure drop the energy loss may be considered negligible.

Although the removal of dust from natural gas has been of prime interest in this study, other applications have not been overlooked. By substituting water for the scrubbing oil it is possible to remove very efficiently many types of airborne dusts. As reported, coal dust may be removed from air or gas. This leads to many possible applications in steel manufacture and in power plants. A further possibility is in removal of ash in various processes. A scrubber may be used to recover valuable dusts that are gas-borne in manufacturing with greater efficiency than in a cyclone unit. Slight modifications enable it to be used to remove dust from air compressor gas, gasoline, or diesel engine intakes. The scope of the program has been broadened to include these as well as other possible industrial applications.

● **Acknowledgment.** The writers wish to express their appreciation to the Stearns-Roger Manufacturing Company and to the University of Colorado Engineering Experiment Station for permission to publish the results of the research program.

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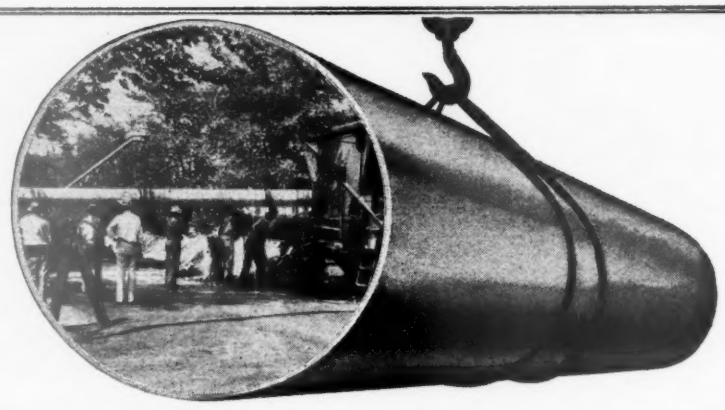

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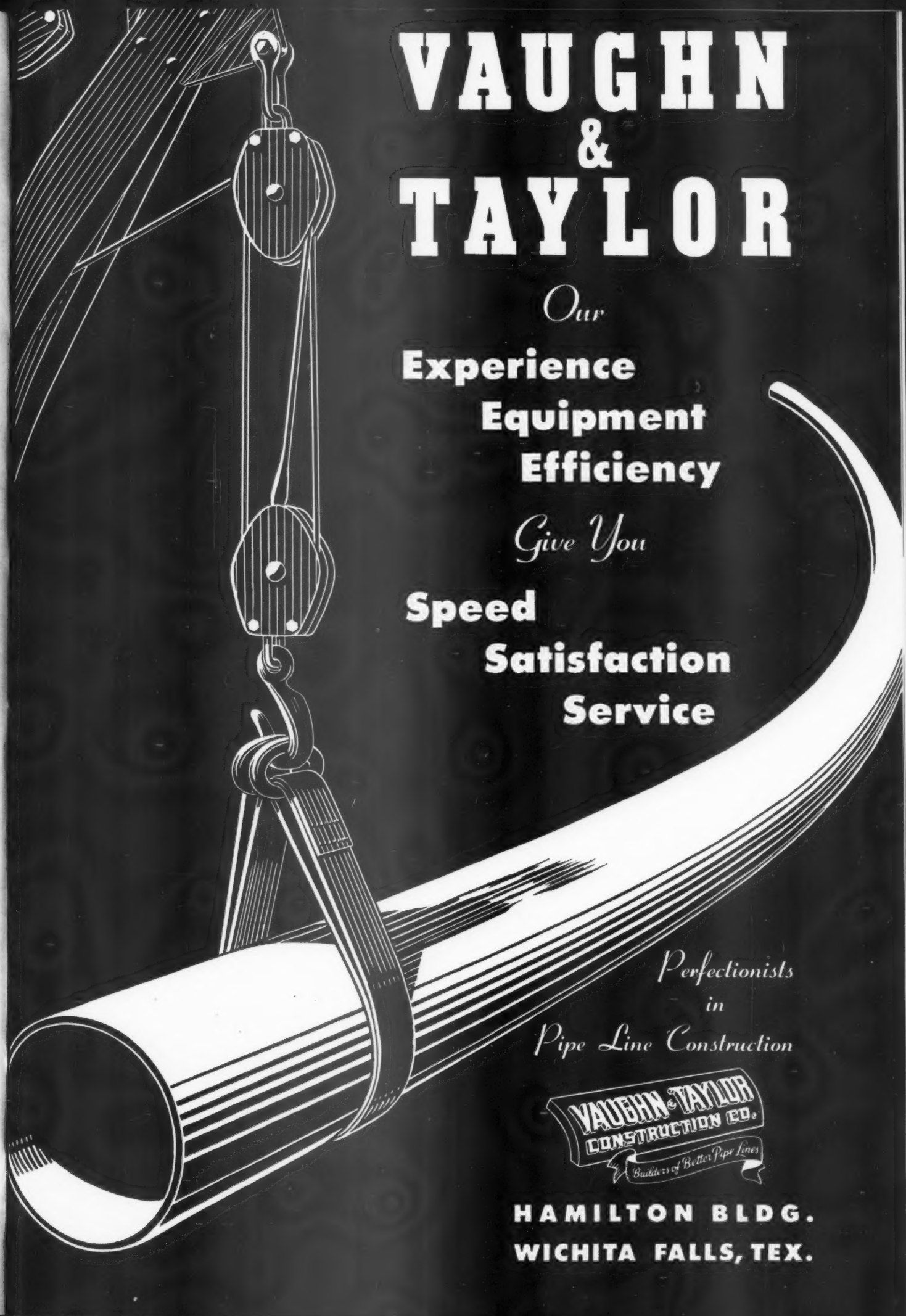
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Orifice meters in oil pipe line service

PRIOR to the use of the centrifugal pump in oil pipe-line service, the volume of oil pumped was estimated by multiplying the number of pump strokes by the total piston clearance, allowing a small percentage for pump slippage. This method worked out quite satisfactorily; however, because it was not applicable to the centrifugal pump, another means of determining the pumping rate had to be found.

EXCLUSIVE

Although some advised against the use of orifice meters in crude oil service, one company experimented with them using specially designed orifice plates. The meters were installed on the discharge lines leading from the centrifugal pumps. They were found to be accurate within 2 to 3 per cent. Their successful use with centrifugal pumps led to their use with reciprocating pumps.

Besides being a reasonably accurate means of determining the volume of oil pumped, the orifice meter was found to serve still another purpose. When it was used in conjunction with a recording pressure gauge, it was possible to determine the source of much trouble in pumping operations.

There are three main sources of trouble in pipe-line service: The engines (or electric motors), the pumps, and the pipe lines themselves. Engines may develop mechanical trouble of one sort or another. Electric motors may develop mechanical or electrical trouble, or the electric power may fail. Pumps may become air bound, they may not fill properly, or they may develop valve trouble or other mechanical trouble. Pipe lines may develop leaks or breaks.

In the case of centrifugal pumps, the following was found to be true. If the static pressure dropped because less oil was being pumped, the orifice meter showed a corresponding decrease in flow. This was indicative of trouble, either in the engine (or motor) or in the pump. On the other hand, if the static pressure dropped because the pumps were delivering more oil (a characteristic of centrifugal pumps), the flow as recorded on the orifice meter increased, thus indicating that there was a leak or break in the line.

In the case of the reciprocating pump, similar conditions were found to exist. A drop in static pressure coincident with a decrease in flow as shown by the orifice meter, indicated that there was trouble either in the engine (or motor)) or in the pump. If there was a drop in static pressure with no change in flow (a characteristic of reciprocating pumps), this was indicative of a leak or break in the line.

One company has used the orifice meter for still another purpose. The application concerns the handling of various products in a looped line, but it could be applied just as well to the "batching" of crudes through a looped line.

A new 8-in. line was laid parallel to an existing 8-in. line of slightly smaller internal diameter. As the lines were looped, they would normally operate at the same pressure. Under these conditions, the velocity of the product in the new line would be greater than that in the old line. This would result in a considerable amount of mixing of the old and new products at the far end of the loop. In order to avoid this contamination, a diaphragm control valve was placed in the new line just beyond the up-stream junction of the loop. A flow nozzle was installed in each line at the junction. The throat of the flow nozzle in the new line was connected to one side of the diaphragm on the control valve; the throat tap of the flow nozzle in the old line was connected to the other side of the diaphragm. The nozzles were designed to create the required differential pressure to operate the control valve. An orifice meter was connected to the throat taps of the flow nozzles in order that there would be a continuous check on the operation of the valve. With the control valve in use, the amount of contamination of the products was found to be negligible.

There are two types of orifice meters —the bellows or mechanical type and the mercury type. With the bellows or mechanical type meter, the lines from the orfice plate to the meter, and the meter itself, are usually filled with oil. In the case of the mercury type instrument, seal chambers and a sealing liquid must be used to prevent the oil from reaching the mercury and forming an emulsion.

Although the orifice meter, if properly installed and maintained, is reasonably accurate for measuring volumes, it is seldom used for dispatching purposes. Instead, either tank gauges or the piston strokes (or both) are used in the case of reciprocating pumps; and tank gauges are used in the case of centrifugal pumps. In the event that it is impractical to use tank gauges in connection with centrifugal pumps, orifice meters are used for dispatching purposes.

The principal function of the orifice meter as used in oil pipe-line service is to make possible an accurate interpretation of a drop in static pressure.

For this purpose the orifice plate is usually installed in the line between the discharge manifold and the header gate. It may be held between two flanges, or it may be held in a standard orifice fitting. In the former case, care must be taken to see that the plate is centered accurately. One means of insuring that the plate is centered, is to design it with an outside diameter equal to the inside diameter of the flange bolt circle. This type plate should have a radial tab on which the diameter of the hole is stamped. This tab not only serves as a means of identifying the plate while it is in the line, but it also acts as a handle for insertion and removal of the plate. With this type installation the insertion or removal of the plate requires that the pumps be shut down and that the line be drained. If the plate must be removed frequently —such as would be the case if scrapers had to be run at frequent intervals—it would be more economical to install a standard orifice fitting. The orifice fitting allows insertion and removal of the plate while the oil in flowing through the line.

Connections to each side of the plate may be made either at the flanges or in the wall of the pipe. Flange connections are ordinarily used because of the simplicity of the installation.

Although the meter may be placed at the orifice plate, it is often on the gauge board in the station. In this case the seal chambers (for use with mercury type instruments) may be placed either at the orifice plate or at the meter. If, however, the oil is viscous, it is best to install the seal chambers at the plate.

The seal chambers, the lines from them to the meter, and the meter itself should be filled with a non-viscous antifreeze solution. It is desirable for the specific gravity of this sealing liquid to be as near 1.000 as possible in order to facilitate the calculation of the orifice plate. Two solutions that may be used for this purpose are: A mixture of ethylene glycol (Prestone) and water, and a mixture of glycerine and water. In order to prevent air from being trapped in the system, it is advisable to slope the lines upward from the orifice plate to the meter. The lines should be laid without sags or over-bends. The sealing liquid should be put into the system from its lowest point. This takes advantage of the natural tendency of the air to rise to a

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higher level as it is displaced by the anti-freeze.

Some companies use direct reading square root charts on their meters; others use charts that are graduated in inches of water. The direct reading chart has the advantage of making it possible to determine at a glance the approximate rate of flow through the line. This is particularly advantageous if the meters are installed on two or more looped lines, all of which operate at the same pressure. Knowing the diameters of the lines and the total flow through them, it is possible to determine the approximate amount of oil that should flow through each line. With this information, it is easy to determine whether or not the lines are operating properly if direct reading charts are used. The disadvantage of the direct reading chart is that it requires a specially designed orifice plate. The plate is usually designed so that the maximum anticipated pumping rate will cause a full scale deflection of the orifice meter pen.

As was noted earlier, the orifice meter is used in conjunction with a recording pressure gauge in order to determine the location of difficulties in pumping operations. It is necessary to have only one recording pressure gauge for use with all the meters on the lines in any loop, for all these lines are operating at the same pressure. This gauge may be a separate recording gauge, or it may take the form of a static pressure element mounted in the orifice meter case and recording on the orifice meter chart. Special charts are available to serve this dual purpose.

There are two principal maintenance problems in connection with orifice meter installations of the type herein mentioned. The first problem is air being trapped in the system, causing a false differential pressure to be recorded on the chart. The second problem is leaks in the lines between the orifice plate and the meter. These leaks allow the oil to work its way to the meter since the oil is of a lower specific gravity than the sealing liquid. This causes a false differential pressure reading and emulsification of the mercury. Of course, if the meter is of the bellows or mechanical type with the entire system filled with oil, small leaks are of little significance. In any event, these problems are easily overcome if the meter is properly installed and maintained.

The orifice meter has proved to be a very satisfactory instrument for use in determining the source of trouble in pipe-line operations. Its use has saved many operating hours that otherwise might have been lost due to unnecessary shutdowns to locate the source of trouble.

★ ★ ★

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VALVES are being thrown into the scrap box day after day by valve users who do not know that an inexpensive seat ring will make it as good as new.

We laugh at the hired girl who told her mistress that the mechanical refrigerator was "no good." The mistress wanted to know why. "It won't make ice," said the girl. So the mistress called up the service department of the power company that had sold them the refrigerator and passed the information along to that department. Came the trouble shooter. He took a look and said to the hired girl, "The ice tray is empty. Don't you put water in it?" Whereupon the amazed girl admitted that she didn't know it was necessary to fill the tray with water in order to make ice.

All of which reminds the writer of the engineer—so-called—who didn't remove the old valve disc when the valve needed a new disc. He put the new disc on top of the old one. And then he complained to the manufacturer because the valve still leaked despite the fact that he had inserted a new disc.

So now, after having a hearty laugh at these people, let's go in and take a careful look at our own plant.

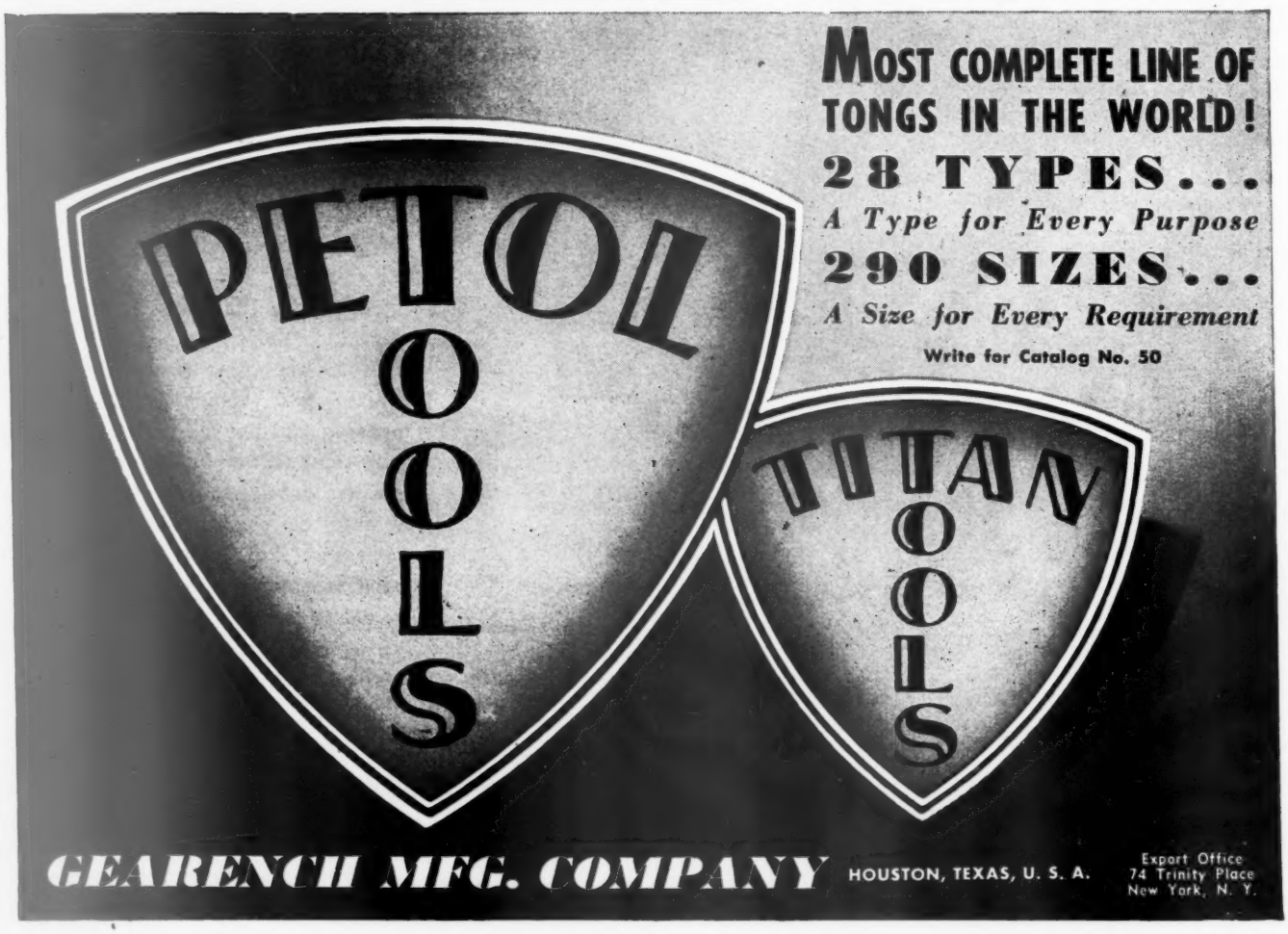

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Fig. 375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel bronze disc.

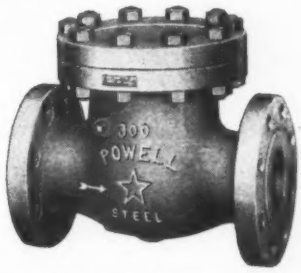

Fig. 3061—Class 300-pound Cast Steel Swing Check Valve. Flanged ends and bolted cap. Disc has ample lift to permit full, straight-way, unobstructed flow through the valve body.

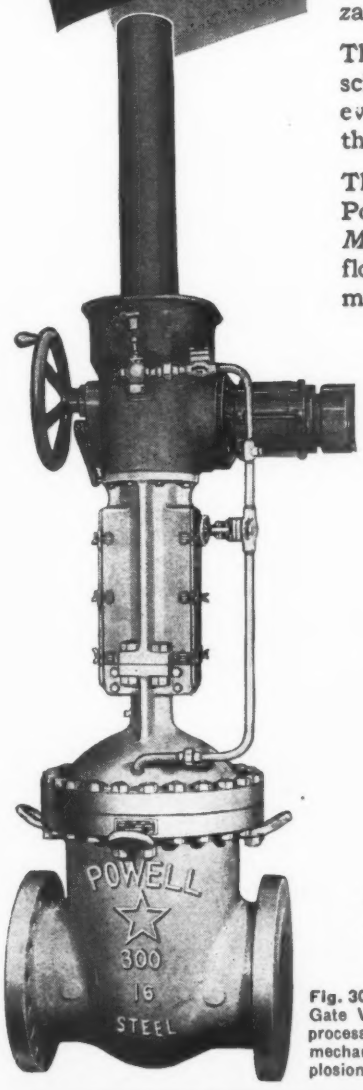

Fig. 3023—Class 300-pound 16" Cast Steel Gate Valve, designed especially for catalytic processing. Has automatic, steam sealing mechanism and top-mounted, enclosed, explosion-proof, electric motor operator.

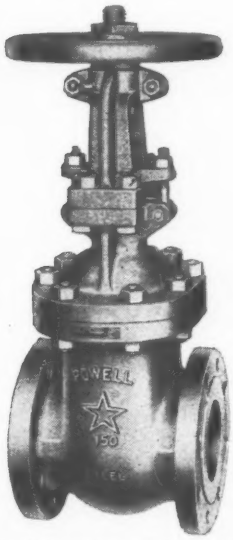

Fig. 1503—Class 150-pound Cast Steel Gate Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke, taper wedge solid disc.

Fig. 1793—125-pound Iron Body Bronze Mounted Gate Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available in All Iron.

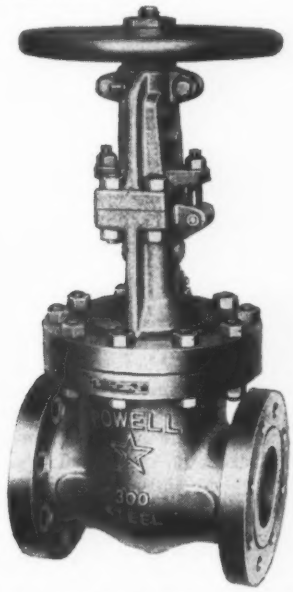

Fig. 3003—Class 300-pound Cast Steel Gate Valve with bolted flanged yoke, outside screw rising stem and taper wedge solid disc.

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R. T. McDonald and Jess Coker, cleaning and welding inspectors, marking corroded sections to be repaired by spot welding or patching.

P. D. Harkins, chief inspector, and W. R. Tierce, who inspects welding of damaged pipe, on duty.

Inspector's job in pipe line reconditioning

By **FRANK H. LOVE,** *Managing Editor*

IN PIPE-LINE reconditioning work the importance of the company inspector to the success of the job may not always be given proper recognition. This is not because the value of his contribution is unappreciated, but rather that his is an unspectacular task that easily may be overshadowed by the more glamorous (if pipelining can be termed glamorous) role played by the construction crews. His work, however, is vital to the success of the project, and the best interest of the company for which he works is his prime consideration, which means that he is concerned with the success of the job as a whole.

EXCLUSIVE

In this fundamental concern, his interest coincides with that of the contractor. As a matter of fact, the pipe-line company inspector never works at cross purposes with the contractor, and his duty is not that of a policeman in any sense of the word. Indeed, the company inspector is welcomed on the job by the contractor because he is of material assistance to him in the performance of the work. This is true for several reasons. Before beginning a job the contractor is provided with comprehensive specifications aimed to tell exactly what is expected of him. Advice from company inspectors concerning the interpretation of these specifications is always appreciated. Moreover, because of the great number of workmen employed on a large construction project, it is no easy task for the contractor's foremen to observe

R. T. McDonald (center) checks knives of cleaning machine.

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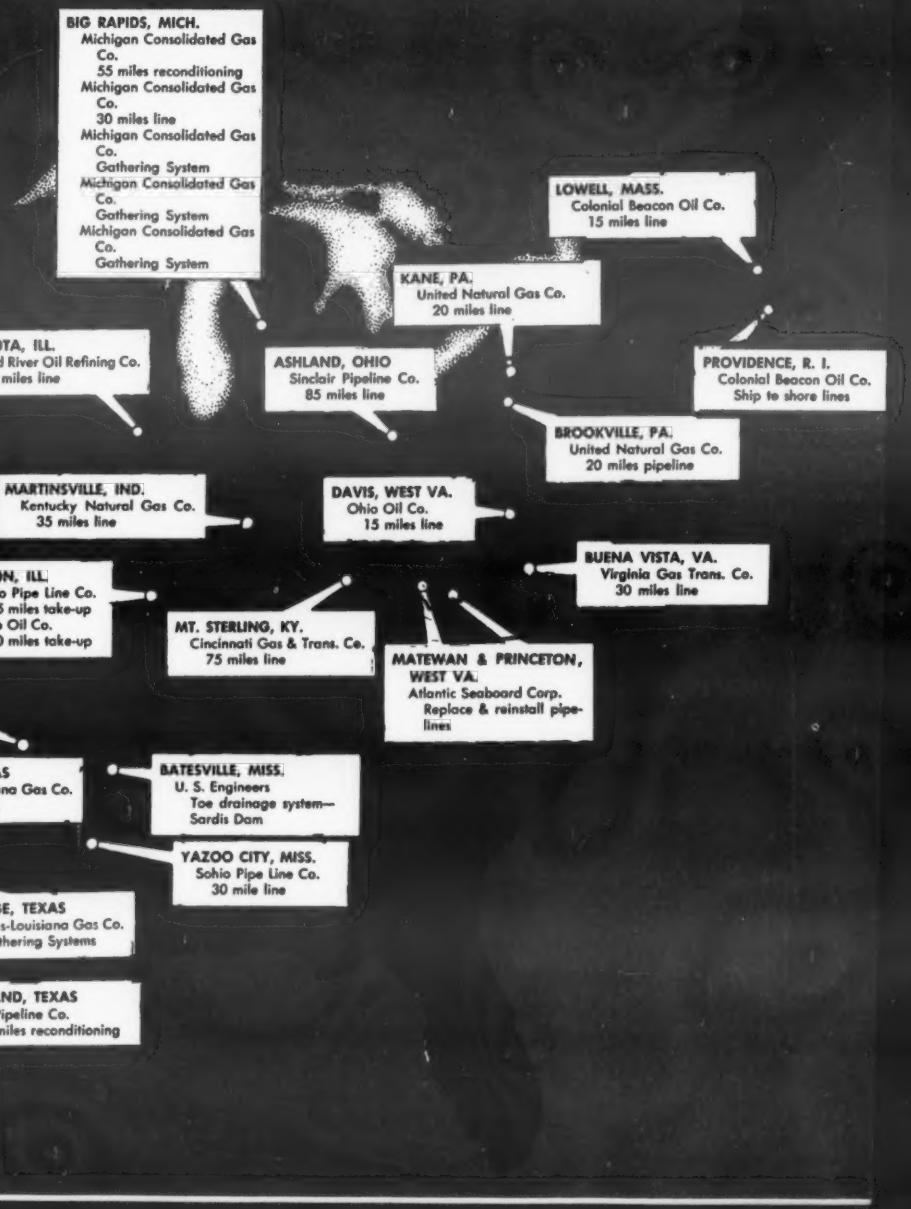

adequately the work of each individual. Here, again, the company inspector moving freely about the job is of inestimable aid.

The company inspection crew is a detailed organization, well planned, and with specific duties for each inspector. An excellent example of such an organizational set-up is that of the Shell Pipe Line Corporation.

Each major job has a chief inspector and under him are either one or two senior inspectors, the number depending on the size of the project. These are experienced maintenance and construction men who are capable of taking over the entire job, including the work of the chief inspector, if necessity demands. A senior inspector or inspector is assigned to each phase of the work. Thus, there are inspectors for (1) right-of-way and ditching, (2) raising pipe and placing skids, (3) cleaning and welding of pipe, (4) coating, and (5) preparation of ditch for lowering in, backfilling, and cleanup.

The chief inspector has the overall responsibility of the job. It is his duty to see that the contractor is properly organized to do the work. He is the contact between the pipe line company and the contractor and has rather broad authority to work out fine points of procedure that occur on every job. He has direct supervision over all inspectors and it is his duty to be certain of the competency of his inspectors. Shell's chief inspectors are men with years of experience in handling pipe-line jobs—none has been in such work for less than 20 years.

The senior inspectors are delegated authority to carry out the orders of the chief inspector. In the latter's absence they act for him. Thus senior inspectors must have a broad experience, in contrast with the other line inspectors who may be experienced only in their particular phase of the work.

The "right-of-way and ditching" inspector is charged with the responsibility of having the right-of-way prepared properly so that work on the line may be carried out efficiently. It is his duty, also, to see that right-of-way restrictions are observed. He must check the crews operating the ditching machines to be certain that pipe being uncovered is not damaged, and—when new ditch is being made—that the trench is of proper depth.

After the pipe has been uncovered and straps have been welded across each joint, raising it from the ditch is of utmost importance because, if not properly handled, it may be damaged or broken. When the pipe is raised, the proper placing of skids is also a vital consideration. In some instances special cribbing or crotching of the line is required. A knowledge of soil types is of value to the inspector of this work because it enables him to recognize immediately a ditch that is likely to cave and to specify the proper size and number of skids that should be used to support the pipe.

R. F. Costin, coating application inspector, takes the temperature on the "dope" kettle.

Scotty Anderson, lowering-in inspector, supervises lowering of coated line back into crumbed-out trench.

G. A. Morrison, coating inspector, "spells" his crew and operates the holiday detector.

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Adequate cleaning of the pipe and the repairing of bad sections or spots are the responsibility of the "cleaning and welding" inspector. The pipe-cleaning procedure consists of three machine operations. First, the pipe is cleaned sufficiently to allow the inspector to determine what areas require spot-welding, half-soling, or casing. The second cleaning is done after repairs have been made to the pipe, and a solution of diluted primer paint is applied during this operation.

This dilute primer solution serves two purposes: (1) It prevents atmospheric corrosion of the metal before the final coating is applied, and (2) it penetrates into the remaining corrosion products, which cannot be removed economically by the cleaning machines, and drives most of the moisture from such corrosion, thereby procuring a better bond for the regular primer. The third cleaning, delayed until after the solution has dried for 24 hours, removes a considerable amount of the corrosion products that have been loosened by the solution, and applies the regular primer. The cleaning and welding inspector also is called upon to supervise the repair of leaks that occur during operations and which require immediate repair.

To guide the inspector in deciding what type of repair to specify, Shell's recommended practice is to spot-weld if the pit penetrates between one-half and two-thirds of the pipe-wall thickness; if the penetration is greater, a patch is specified. If the penetration is less than half the pipe-wall thickness, no repairing is done unless a particularly large area is involved. Half-soles or casing are used when pipe has been weakened by extensive corrosion. If any considerable length of pipe has been thus weakened, the section is cut out and replaced with new pipe. Such a step may be ordered by the inspector at his discretion.

The duty of the "coating" inspector is to procure an effective coating application. Thus he must keep constant surveillance over the coating equipment and be certain that the regular primer and enamel are applied to the proper thickness, and that the imbedded fibre-glass and asbestos-felt wrappers are properly placed. He also must supervise the running of the holiday detectors and the patching of the holidays found.

The important task of the "lowering-in" inspector is to get the reconditioned pipe lowered into the trench and backfilled without damage to the coating. This involves the proper preparation of the trench, proper handling of the pipe, and proper backfilling. After the pipe is covered, the right-of-way is cleaned up and fences are inspected to make certain they have been left in at least as good a condition as when the work began.

The project chief inspectors work under the general supervision of the area superintendent and area engineer. Technical assistance is provided by the chief corrosion engineer and area corrosion engineer, the latter usually spending much of his time on the job. The reconditioning procedures and inspection techniques have been developed through gradual evolution by Shell Pipe Line over a period of 13 years' systematic study of pipe-line corrosion and its effective mitigation.

Inspection organizations of the type discussed in this article are being now used by Shell Pipe Line Corporation on an extensive reconditioning program in Texas, Oklahoma, and Kansas. Various projects in progress or recently completed include 80 miles of 10-in. line between Houston and Kilgore, Texas; gathering lines of various sizes in the East Texas field; 32 miles of 10-in. line between the Archer and Haskell stations in North Central Texas; 56 miles of 10-in. line between Ryan station in South Central Oklahoma and Cushing, Oklahoma, and 41 miles of 6-in. line between Arkansas City, Kansas, and Tonkawa, Oklahoma.

Contractors on this work are Anderson Brothers, Houston, Texas; Holland Construction Company, Tulsa, Oklahoma; United Construction Company, Fort Worth, Texas, and Wood Engineering Company, Tyler, Texas. ★★★

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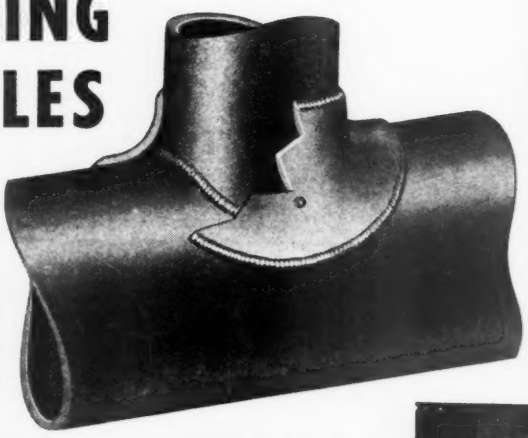

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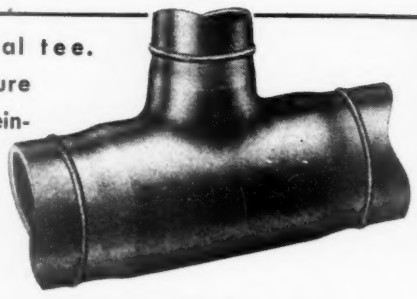

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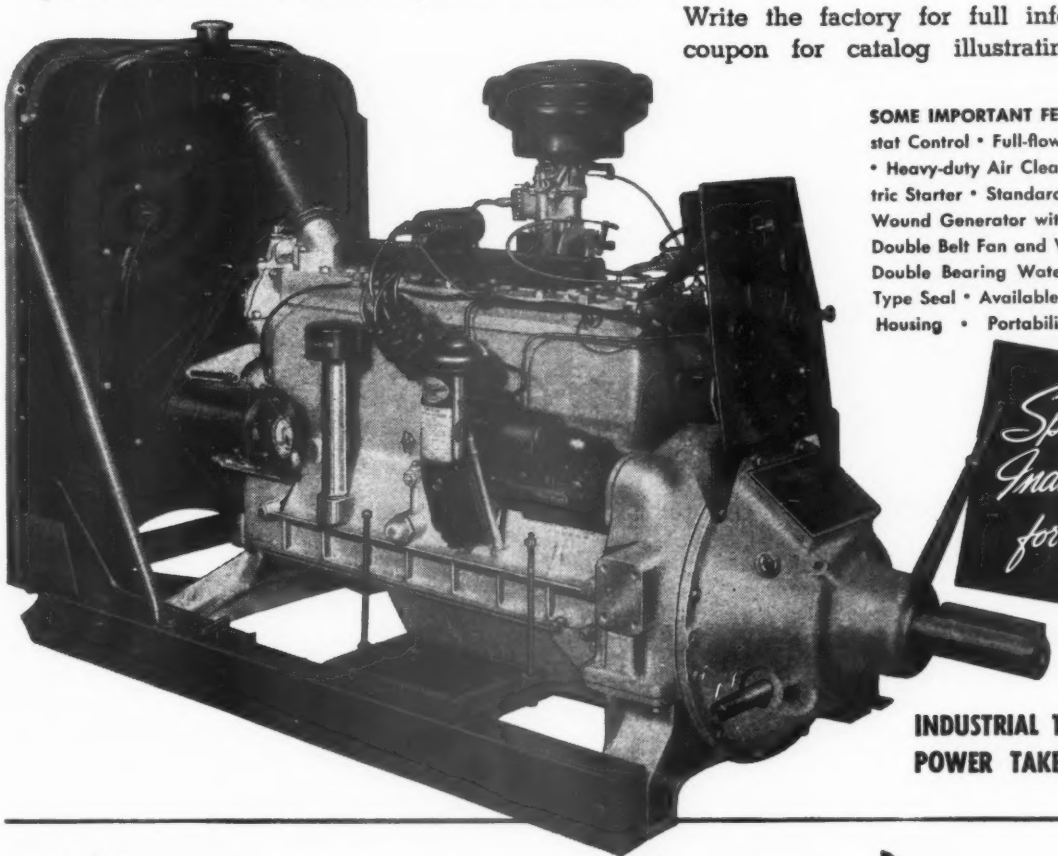

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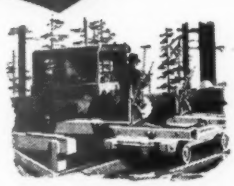

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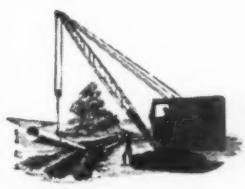

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Workable critical velocity formula

By **ROLAND O. COX,** Lone Star Gas Company

EXCLUSIVE

It is often necessary to determine the approximate volume of gas flowing through an opening such as a hole in a gas line, a blow-off on a gas line, or through a restricting orifice in a pipe, where the setting of a meter is not possible or desirable.

If the flow is through an orifice or nipple and velocity through it is at the maximum or "critical" rate, and the upstream pressure is known or can be determined, the approximate quantity of gas passing can be determined by the following simple formula:

$Q = D^2 P_1$.

Where:

Q = thousands of cu ft per hr at a pressure base of 14.9 psia, 60F temperature, and 0.60 specific gravity.

D = diameter of orifice or nipple, in.

P_1 = upstream absolute pressure.

For a 1-in orifice or nipple, Q is equal to P_1.

The effective diameter of an irregular opening, such as a regulator valve, can be determined approximately by the formula if velocity is critical and the upstream pressure and quantity of gas passing is known.

For gases with specific gravities other than 0.60, and when the flowing temperature is other than 60F, the quantity obtained by the above formula can be corrected by use of the regular multipliers for orifice meter measurement, or by the following:

Multiplier for specific gravity = $\sqrt{\frac{0.60}{G}}$,

where G is the actual specific gravity.

Multiplier for flowing temperature = $\sqrt{\frac{520}{T+460}}$,

where T is the actual flowing temperature.

Critical or maximum velocity is attained when the downstream absolute pressure is about 55 per cent or less of the upstream absolute pressure; or for practical purposes when the upstream absolute pressure is at least twice the downstream absolute pressure; or stated still another way, when there is a 50 per cent or more drop in pressure across the orifice or nipple.

When flow is from a vessel or pipe into the atmosphere, the pressure inside the pipe or vessel must be about 14 psig to create maximum or critical velocity through the opening. The upstream pressure for gas flow from a pipe or blow-off into the atmosphere can be obtained with a pitot tube inserted in the plane of the opening and in line with the center of the opening, as explained for use of the "Reid Open Flow Tables."* As the pitot tube converts velocity into the static pressure or head that causes the flow, the true upstream gauge pressure can be read from a pitot tube.

The derivation of the critical velocity formula is as follows:

The maximum or critical velocity that any gas can attain is equal to the velocity of sound in the gas. The velocity of sound in a gas varies:

(1) Directly as the $\sqrt{\text{ratio of specific heats}}$

(2) Directly as $\sqrt{\text{absolute temperature}}$

(3) Inversely as $\sqrt{\text{specific gravity}}$

The velocity of sound in air at 32F is approximately 1087 fps, and at 60F would be equal to:

$$1087 \sqrt{\frac{520}{492}} = 1117 \text{ fps.}$$

The ratio of specific heats for air = 1.403.

The velocity of sound in any gas would therefore be equal to:

$$\frac{1117}{\sqrt{1.403}} \sqrt{\frac{K}{G}} = 943 \sqrt{\frac{K}{G}},$$

where K is ratio of specific heats and G is specific gravity.

Assume a natural gas with a K value of 1.30, specific gravity of 0.60, at 60F:

V_s (velocity of sound) =

$$943 \sqrt{\frac{1.30}{0.60}} = 1386 \text{ fps,}$$

which is the maximum velocity that the gas can attain.

Maximum velocity through an opening or outlet is obtained when:

$$\frac{P_2}{P_1} = \left(\frac{1+K}{2}\right)^{\frac{K}{1-K}} = R$$

Where:

P_1 = upstream pressure, abs,

P_2 = downstream pressure, abs, and

R = critical pressure ratio.

From the above formula, R = 0.546 when K = 1.30, and critical velocity is attained when the downstream absolute pressure is 55 per cent or less of the upstream absolute pressure. The static pressure of the jet (where the gas stream emerges from the opening) at critical velocity for the gas in question would be equal to 0.546 P_1.

Let:

Q_1 = cu ft of gas per hr at 14.9 psia pressure base,

C = coefficient or efficiency factor of opening,

A = area of opening, sq ft,

V_s = velocity of sound in the gas = 1386 fps,

P_1 = upstream absolute pressure, and

R = critical pressure ratio = 0.546.

Then:

$$Q = 3600 \, CAV_s \frac{P_1 R}{14.9}$$

For a circular opening $A = \frac{\pi D^2}{4 \times 144}$

Where:

D = diameter,

$$Q = 3600 \frac{C \pi D^2}{576} \times 1386 \times \frac{0.546 P}{14.9}$$

$$= 999 \, CD^2 P_1 \text{ cu ft per hr.}$$

If Q = M cu ft per hr, the 999 would cancel out, and

$Q = CD^2 P_1$ for 0.60 specific gravity gas in M cu ft per hr at 14.9 psia pressure and 60F temperature.

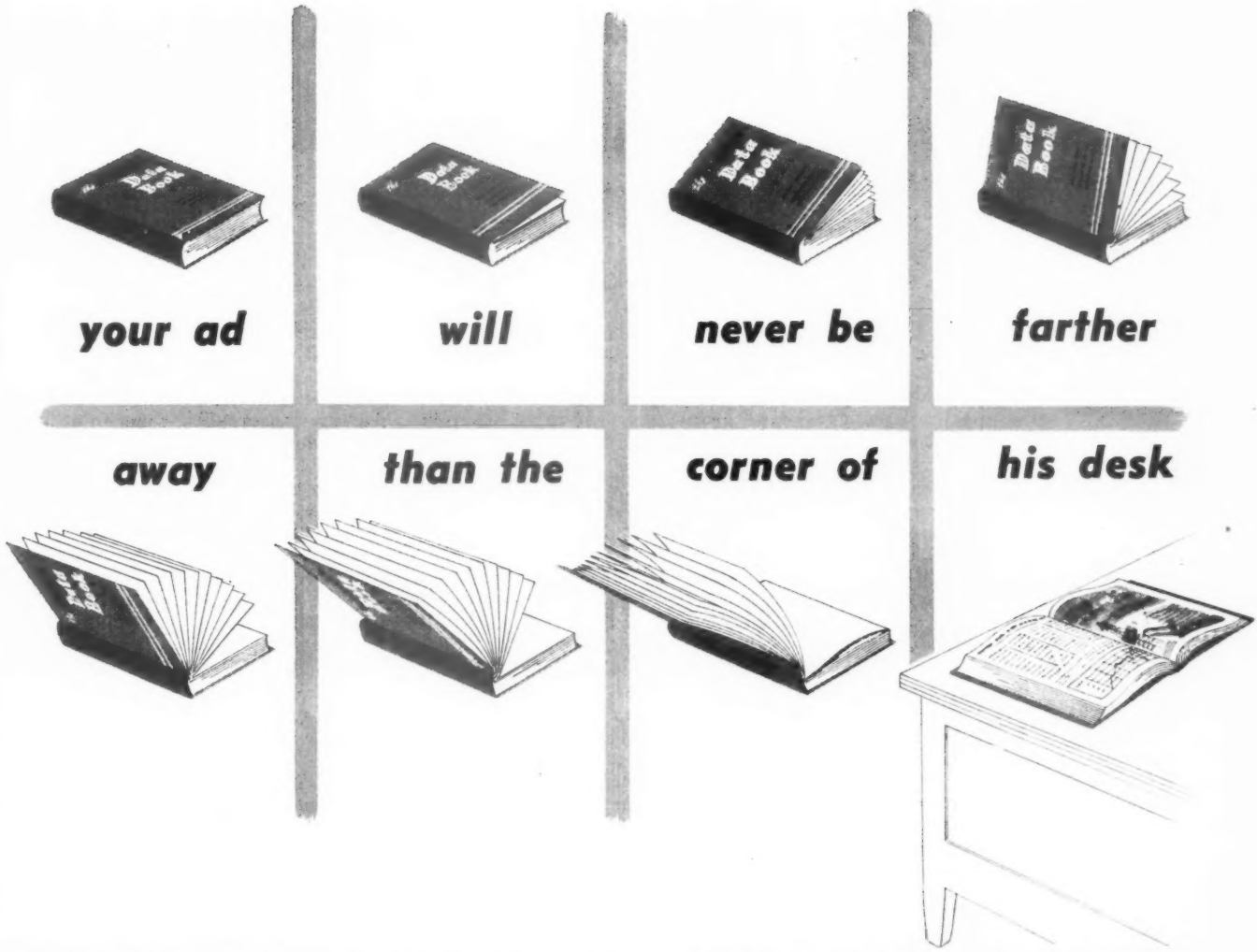
The efficiency factor C can be considered as being equal to unity for the practical purposes for which the formula is intended. A comparison of values from the formula with the maximum values given for both choke nipples and orifices in Deihl's *Natural Gas Handbook* will show close agreement. Values from the formula also agree closely with values given in the table "For Determining Open Flow of Gas Wells with Pitot Tube When Impact Pressure Exceeds 15 Pounds," by Walter Reid in 1929. It is known, of course, that no nipple or orifice would have an efficiency of unity, and that the actual efficiency would be less. The deviation of gas from Boyle's Law, however, has an offsetting effect, and the deviation is not taken into account in the formula.

For flows where P_1 is more than 500 psia the correction for deviation from Boyle's Law will have an appreciable effect, but not so much as would appear at first glance. At critical velocity the absolute static pressure of the gas stream is about one-half the upstream absolute pressure, regardless of how low the pressure drops after leaving the opening. The deviation correction, therefore, is applicable to about one-half the upstream pressure. Thus, if P_1 is 600 psia, the static pressure of the stream is about 300 psia, and the deviation correction for 300 lb should be applied. The direct deviation correction would be applicable, however, instead of the square root of the correction as in orifice meter measurement. The deviation factor for an average natural gas at 300 psia would be about 4 per cent.

The writer did some of the pencil work for Mr. Walter Reid* during the development of the open flow tables in 1928, and jotted down the formula given herewith. Having used it so many times for approximating gas flows under applicable conditions, it was thought that it might prove useful to some of the readers of *The Petroleum Engineer*.

★★★

*The late Walter Reid, former president of Southern Union Gas Company, who developed tables for the open flow measurement of gas wells, and also the Reid Method for testing vapor pressure of petroleum products.



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OFFICIAL SOURCE OF INFORMATION FOR THE WORLD'S OIL AND GAS INDUSTRY

Submarine pipe lines at Ventura

By F. E. COYLE, W. S. DAVIDSON, and B. R. SWANSON
Tide Water Associated Oil Company

EXCLUSIVE

THERE are several different ways to transport crude petroleum products from the oil field to the refinery. One of the most economical methods for long distances is water transportation, provided it is available. In order to transfer petroleum from the shore to the tanker, the two common methods in use are by pipe lines installed on a dock or by submarine pipe lines.

Dock loading is used where such a facility is available, although a dock is not commonly constructed solely for loading tankers. A dock is often needed for the loading or unloading of equipment, materials, supplies, and barreled petroleum products, along with the bulk handling of petroleum. When the only items to be loaded are bulk petroleum products on tankers, the submarine pipe line is the most economical installation.

● **General layout of facilities in the sea.** Tide Water Associated Oil Company's loading facilities at Ventura are typical submarine line installations. There are two lines in use at this location. One is a 16-in. line used for crude oil having a gravity of 30° API and the other is a 10-in. line used for 24-25 RVP natural gasoline. The sea end of the pipe lines are approximately 3000 ft from the shore line where the depth of water is 36 ft at low tide.

The 10-in. gasoline pipe line was installed in 1930 with 10-in. screwed pipe weighing 45 lb per ft. The collars were welded and all exposed threads were welded over after the pipe joints were made up in order to prevent corrosion in the threads and cracks. The pipe was coated with a primer, then an enamel, followed with a cloth wrapper and another coat of enamel.

The 16-in. crude oil pipe line was installed in 1933 with 16-in. pipe weighing 93 lb per ft. The pipe was welded and a protective coating applied, similar to that used on the gasoline line.

On the end of the 16-in. crude line, there are five sections of 10-in. submarine hose. Each hose section is from 25 to 30 ft long, with a 250 psi steel flange on each end. These hoses are constructed of synthetic rubber with either steel wire or steel bands as reinforcement. A hydrostatic test of 200 psi is put on each section of hose before it is installed in the line.

On the end of the 10-in. hose an 8-in. by 10-in. steel ell is installed with a steel blind on the 8-in. side of the ell. The blind is used to blank off the end of the submarine line as there is no valve on the end of the line. The blind is used in place of a valve for several reasons, probably the most important being that it is considered a positive shut-off. Also, a valve would be difficult to maintain and operate properly under these adverse conditions; and the extra weight and size of a valve on the end of the line is a disadvantage when raising and connecting the line to the tanker.

A marking buoy is attached to each end of the hose in order to show the location of the hose as it lies on the bottom, and in order to aid the vessels when working into position to begin loading.

The marking buoys are attached to the hose with ⅝-in. chain. At the sea end of the hose a 6-in. rope is attached to the hose and extended to the surface of the water where it is tied to the buoy. This rope is long enough to reach the deck of the vessel so that it can be used to pull the hose up in order to make the ship connection with the submarine line.

Surrounding the end of the submarine line are five mooring buoys attached to 8-ton anchors with 2½-in. anchor chain. The tankers are moored to these buoys while being loaded, although under normal conditions only three of the buoys are used. During rough seas, it is sometimes necessary to use more than the three buoys to secure the ship properly.

The sea end of the 10-in. gasoline line is similar to the 16-in. crude oil line, but five sections of 8-in. loading hose are used on this line instead of the 10-in. loading hose that is used on the 16-in. line. There is a marking buoy on each end of the 8-in. gasoline hose, as there is on the crude line. The ends of the crude and gasoline lines are 200 ft apart, therefore, the same mooring buoys are used for loading either gasoline or crude oil.

A telephone cable is installed between the pipe lines out to the end of the pipe. At this point, the cable is split with one branch going to the 10-in. crude oil hose and the other branch to the 8-in. gasoline hose. The telephone cable is tied to each hose with rope lashings. At the ship's end of the hose the conductors in the cable are exposed so that clip connections can be made to a telephone on board ship. In general, the ship has a telephone permanently installed for this use, but a portable telephone box is available at Ventura if it is required. The telephone cable is a six-conductor cable with a heavy synthetic rubber cover to withstand the rough conditions that it is subjected to in the sea.

The submarine line loading facilities at Ventura are not particularly well protected from the sea. As the prevailing wind is from the southwest, the ships are anchored so that they will head in that direction in order to reduce the movements of the ships while loading. A heavy surface swell is common at Ventura, although not much trouble is encountered from ground swells, which would be much more of a problem than the surface swells. Although the prevailing wind is from the southwest, the heavy storms are from the southeast, from which direction there is no protection at Ventura. The southeasters are infrequent, but when they do occur, ships cannot come in to load if the wind is of any appreciable intensity.

This section of the coast consists of a sandy clay bottom, which makes a good holding ground for the ships' anchors. A satisfactory holding ground is important for the safety of the ships, which must anchor in close to the shore for submarine pipe-line loading.

● **General layout of facilities on shore.** The foregoing has described the arrangement of the submarine pipe-line facilities from the sea end. The following is a brief description of the land facilities.

Crude oil line: As stated previously, there are 3000 ft of the 16-in. crude oil pipe line in the water. On the shore, block gates are installed in the line at the "look-out" station, which is approximately 200 ft back from the water line. A telephone is installed at this point as well as an air compressor and an air whistle that is used to signal the tankers in event of a failure of the telephone system.

From the "look-out" station, the 16-in. line is installed along the coast line for 2900 ft to the marine terminal where the pumps and storage tanks are situated.

The marine terminal storage consists of two 55,000-bbl tanks, which are used for crude oil. The plant has a fire foam system as fire protection for the tanks and pump house.

The crude oil pumping equipment consists of two single stage centrifugal pumps with a 250-hp electric motor as a drive for each unit. The pumps are operated in series, with each unit raising the pressure by 70 psi, for a total pumping pressure of 140 psi. A loading rate of 8000 bbl per hr is obtained at this pressure.

At the "look-out" station, the submarine pipe lines are connected to a 12-in. pipe line, which is used to handle the ballast from the tankers. This line is 700 ft long and runs into a 5000 bbl bal-

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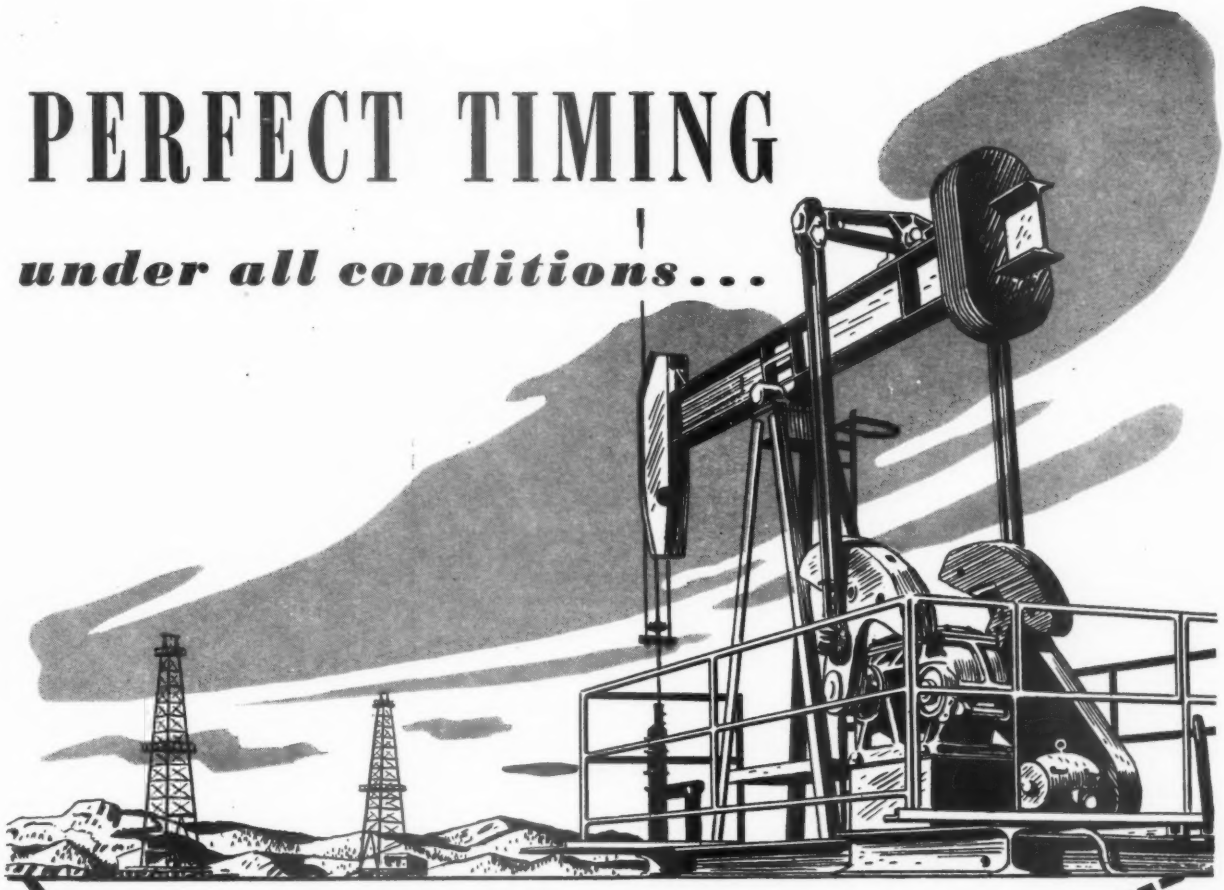

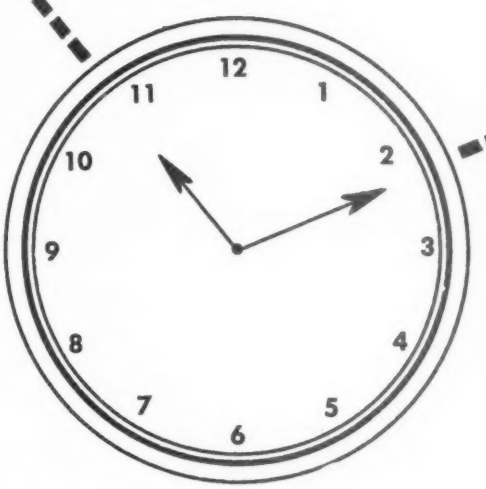

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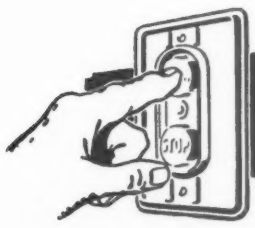

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last tank. The ballast material is drained into a sand sump where the water can soak into the ground, with the small amount of oil in the ballast being removed when a sufficient quantity has collected.

Gasoline line: The gasoline line has 3000 ft of 10-in. pipe line under water, but the remainder of the line is 8-in. pipe. No storage tanks or pumping equipment are available at the shore for the gasoline loading; therefore, the gasoline is pumped directly aboard ship from the tank farm, which is three miles inland. This makes it necessary to use 21,000 ft of 8-in. pipe line to connect to the submarine line.

During gasoline tanker loading operations, a man is stationed at the "look-out" station. This station operator is used to open or close the pipe-line valves, to relay messages by telephone, or air whistle if necessary because of submarine telephone cable failure, and to keep an eye on the loading operations. In case of submarine line failure or trouble on board ship, the "look-out" man can shut down the line immediately in order to prevent any gasoline from escaping into the ocean.

The gasoline pumping rate for loading ships is 2000 bbl per hr at a pressure of 175 psi. The pumping equipment consists of a deep well booster pump at the suction of the 80,000-bbl storage tank, which pumps into an electric motor driven centrifugal pump. The booster pump is driven by a 15-hp motor and raises the pressure by 20 psi. The centrifugal pump is a two-stage unit driven by a 200-hp electric motor. The booster pump is necessary at the tank in order to maintain a constant flow to the suction of the centrifugal pump, because of the volatility of the natural gasoline handled.

Loading ships: In order to moor the oil tankers it is necessary to have the assistance of a launch to run the lines to the mooring buoys. Besides mooring the tanker, the launch is used to assist in making the necessary connections to raise the submarine hose. The launch used for Ventura is kept at Santa Barbara, as there is no safe place to moor it at Ventura. The distance from Santa Barbara to Ventura is approximately 20 miles, which is a three-hour trip each way for the launch, although this time will vary with weather conditions.

The launch, "Flying A," is a 43-ft, 12-ton vessel with a 5.7-ft draft. It is driven by a 50-hp diesel engine, with a cruising speed of eight knots. It has a maximum cruising range of 1200 miles, and a fuel consumption of 3 gal per hr.

The launch is scheduled to be on hand at Ventura when the tanker arrives; therefore, it must leave Santa Barbara 3 hr ahead of the scheduled arrival of the tanker. As it takes an average of 16 hr from the time the tanker arrives until it leaves with a full cargo, the total launch service time, including traveling time to and from Santa Barbara, is 22 hr per vessel.

The 16-hr loading time for the tankers is increased considerably in some instances because of storms or other trouble that may develop in loading the ship. In general, a ship will not moor at night at Ventura during heavy weather, but it will anchor in deep water and wait for daylight before coming in. It is seldom that the ship will not come in during the daylight hours, although this would be the case during a heavy southeaster.

Failure of the loading equipment and accidents cause some loading delays, although these instances are infrequent. Past delays have been caused by the ship's propeller getting caught in the marker buoy chain on the end of the hose, a leak occurring in the pipe line on shore, the marker buoy sinking because of a leak, the chain breaking or coming loose on the marker buoy, and the ship's mooring line breaking and causing the ship to move and break loose from the submarine line. Any time the marking buoy chain on the end of the submarine hose is broken or lost on the bottom, it is necessary either to grapple to pick up the chain or to send a deep sea diver down to attach a line to the end of the hose so that the hose can be raised to connect to the ship. It is an easy operation if the chain or bull rope on the end of the hose can be picked up by grappling, but if a deep sea diver is needed, it is a long and costly operation.

When both the launch and tanker have arrived at Ventura under normal conditions, the tanker moves into position and drops its anchors. Then the launch runs the ship's mooring lines to the various mooring buoys. The captain of the ship specifies the number of mooring lines he will need, with three lines being used under normal conditions. By use of the mooring lines and winches the ship can move itself into the exact position required to raise the submarine hose. It is important that the ship be positioned carefully and accurately, otherwise the chain and rope used for raising may get caught in the ship's propeller or the hose may be kinked, or the ship may be so far out that the connection cannot be made to the ship. The spotting of the ship accurately can be accomplished by using the various buoys as markers. If the captain of the ship is not familiar with the arrangement at Ventura, the launchman can inform him of the proper position for the ship.

With the ship in position, the "bull rope," which is connected to the end of the submarine hose and to the top of the marking buoy, is used to pull the hose up to the ship's deck so that the submarine line can be connected to the pipe lines on the ship. The blind flange is removed from the end of the submarine line and the proper connection is made.

The submarine pipe line is kept full of water, except when loading operations are underway, from the sea end to the block gates on shore at the "look-out" station. Before the tanker leaves after each load, it pumps the submarine line full of sea water so that no oil will be spilled into the sea if the pipe line would happen to break. After the submarine

THE AUTHORS

F. E. Coyle is superintendent of the Southern California pipe line department of Tide Water Associated Oil Company. Started working in the oil industry in 1911 for the Amalgamated Oil Company in Los Angeles.

From 1911 to 1916 he worked at various operating and mechanical jobs for the Amalgamated. In 1916 he went with Associated Oil Company and until 1923 was in the engineering and construction department of the company, during which time he was on various plant installations at Avon refinery, Gaviota refinery, Santa Maria pipe line system and others. In 1922 when extensive oil field development started in Southern California he returned to Los Angeles and was in the engineering and construction department during the time the present pump stations, pipe lines, tank farms, and marine terminals were being constructed. Upon completion of construction in this area he was made superintendent of the pipe line department on April 1, 1923, for the territory from Port San Luis south to the Huntington Beach oil field, Orange County, California.

W. S. Davidson is assistant superintendent in the Southern California pipe line department of Tide Water Associated. First started working for this company during school vacations in 1929 in the San Joaquin Valley pipe line department. Has been continuously employed since 1936. He has worked as roustabout, boiler fireman, gauger, assistant oil dispatcher, foreman, and in 1939 was transferred to the Southern California pipe line department as assistant to the superintendent. In 1946 he was promoted to his present position of assistant superintendent.

B. R. Swanson is field engineer in the Southern California pipe line department of Tide Water Associated. Immediately after graduation from Stanford University in 1940 went to work for "Associated" in the San Joaquin Valley pipe line department where he worked at various classifications such as assistant pipe line foreman, estimator and material engineer and field engineer. In 1943 he was transferred to his present position of field engineer in the Southern California pipe line department.

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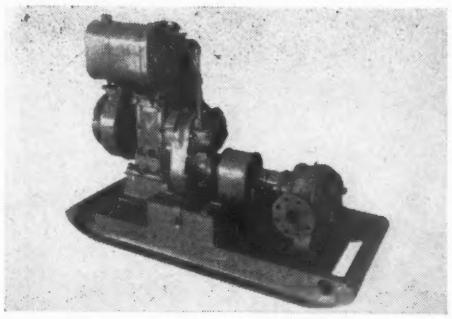

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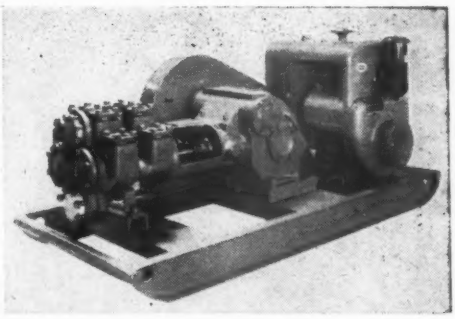

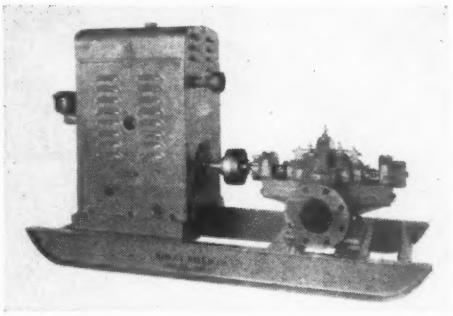

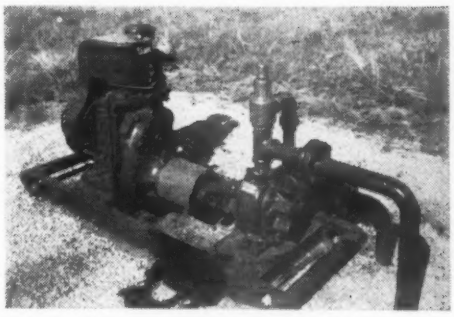

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line has been connected to the ship, the block gates on the line are opened and a test pressure of 100 psi is applied to the line by the pumps on shore before any products are moved through the line.

Immediately after the submarine hose is raised, the telephone on the ship is connected to the submarine telephone cable so that communication can be established between the ship and shore. The communication system is important in conducting the tests and loading procedure. Communication methods and procedure will be discussed more fully later in this article.

With the testing completed any ballast that the ship may be carrying is pumped from the ship into the 5000-bbl ballast tank on shore, after which the loading of the crude oil is begun. It takes approximately 10 hr of actual pumping time for either a cargo of crude oil or gasoline for the ships that normally load at Ventura. The crude oil ships are loaded at the rate of 8000 bbl per hr and carry from 70,000 to 80,000 bbl when fully loaded, whereas the gasoline ships are loaded at the rate of 2000 bbl per hr and carry 20,000 bbl when fully loaded.

During the last ten minutes of loading, the pumps are operated at a reduced speed in order to lessen the chance of running the tank over as it is being topped off. The loading pumps are completely shut down on telephone orders from the ship.

After loading is completed, the submarine pipe line is filled with sea water by pumping from ship to shore. The quantity of water needed to fill the pipe line is determined by gauging the oil received in the shore storage tanks. The 16-in. crude oil line has a capacity of 715 bbl and the 10-in. gasoline line has a capacity of 305 bbl. With the line full of water, a pressure test is placed on the line to assure that the line is tight before it is returned to the bottom of the ocean.

The end of the submarine line is blinded after it is disconnected from the ship, and then is lowered into position. Considerable care must be exercised in lowering the submarine hose to avoid leaving the hose kinked. It is standard practice to pull the ship ahead with the anchor chain as the hose is lowered in order to stretch it out in a straight position. As soon as the hose is lowered, the launch is used to unfasten the mooring lines; then both the tanker and launch are ready to be on their way.

Communications: The present telephone system of communications at Ventura works very satisfactorily in general, but there are certain disadvantages to this system. Most of the telephone trouble is encountered in maintaining a telephone cable under water, especially ocean water where the currents and tides cause a shifting of sand and the movement of the cable. Under the present system, the main telephone cable is installed to the end of the submarine pipe lines from which place a branch cable is run to each, the 8-in. gasoline line hose and the 10-in. crude oil line hose. The splice where the branch cables are connected to the main cable is the weak point in the underwater cable. A renewal of this splice is required every one or two years.

Prior to the present arrangement of having the telephone line connected to each, the gasoline hose and the crude oil hose, the telephone cable was installed directly to a point between the ends of each hose, with a buoy connected to the end of the telephone line. In this way, the telephone system was independent of the submarine pipe lines. This method of operations had two main disadvantages. First, the telephone line had to be raised by the ship separately from the hose, which took extra time. Second, the telephone cable near the end was kinked and the conductors broken frequently because of the movement in the cable caused by the ocean currents and tides. When the telephone cable is tied to the submarine hose, it is anchored sufficiently to reduce most of the underwater

FIG. 1. Tanks at marine terminal.

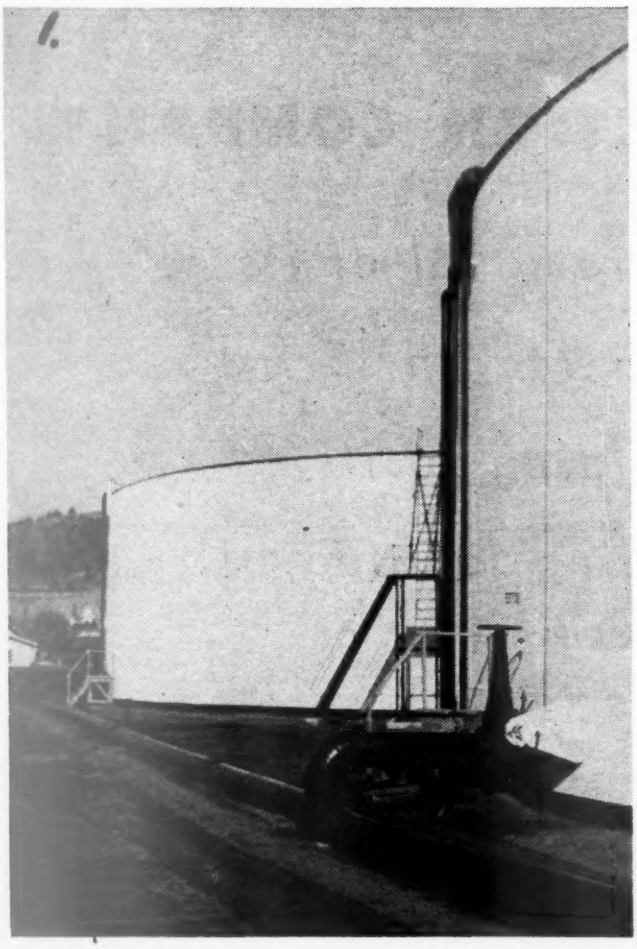
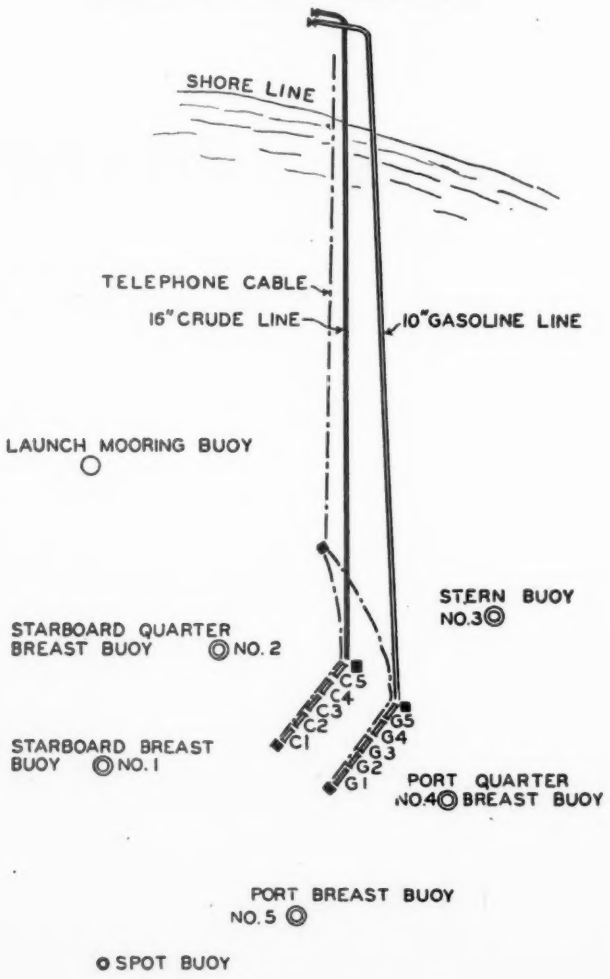


Diagram of marine loading facilities.



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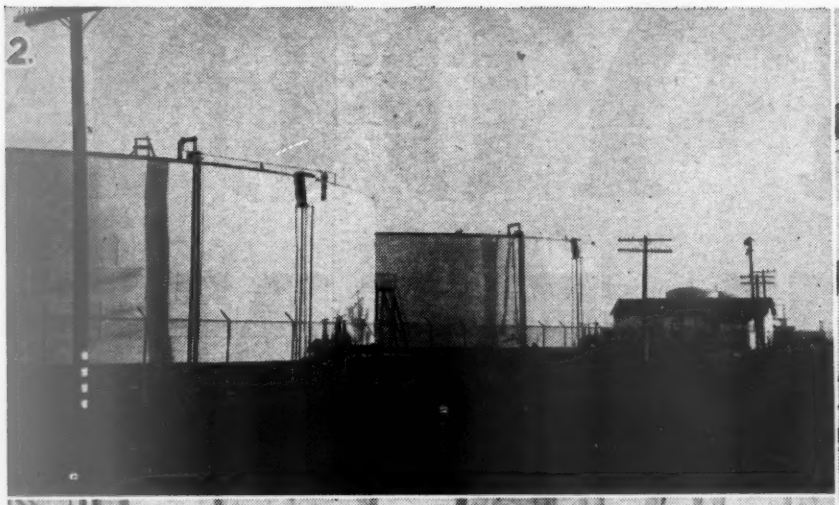

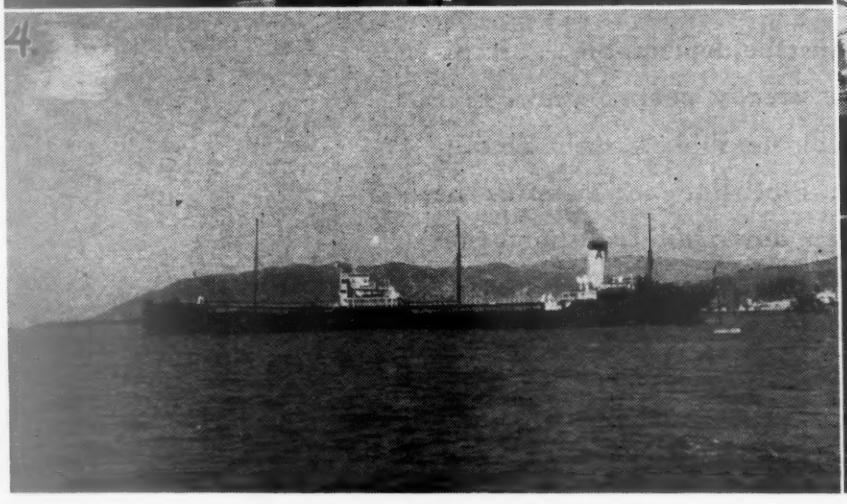

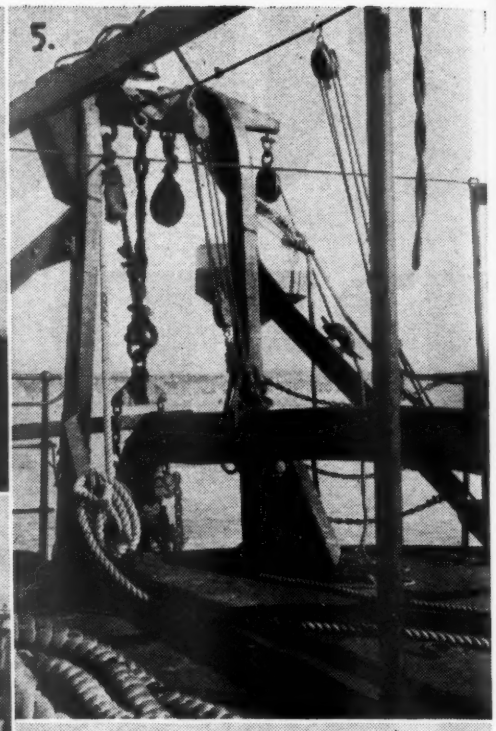

movements. An advantage of the separate telephone system is that communication can be established with the shore even though it is not possible to raise the submarine line hoses.

Without the telephone system in operation it is difficult to communicate between ship and shore to conduct loading operations, such as to determine when to test line, begin loading, stop loading, flush line, and to perform other necessary coordinated acts. The high cost of any damage to the submarine pipe lines or the ship, or the spill of any oil, or the delay of a ship makes the proper loading procedure and operation extremely important. An emergency system of whistle signals has been arranged for use in case of telephone failure. Both the ship and the shore have a list showing the meaning of the different number of whistle blasts for the various acts required, such as when to start and stop pumps. Although this whistle system is used during emergencies, it is not very satisfactory as it is easy to misinterpret the whistle signals. Some confusion has been caused in the past by train whistles as the railroad track runs adjacent to the marine terminal.

FIG. 2. Marine terminal tanks and pumphouse.

FIG. 3. Pumps at marine terminal.

FIG. 4. Ship loading crude oil. Note hose attached to stern.

FIG. 5. Submarine hose connected to ship's hose on stern of ship.

FIG. 6. Hose from submarine line connected to stern of ship. The small buoy, hanging over the stern, marks the location of the end of the hose when lowered into water to connect with shore.

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Properties of sulphur in oil compiled

As a part of a research program designed to assist refiners in utilizing high-sulphur crude oils, the Bureau of Mines has compiled information on the physical properties of several sulphur compounds likely to be found in petroleum, Dr. R. R. Sayers, Director of the Bureau, announced.

Based on cooperative work between the Bureau and the University of Wyoming, at Laramie, Wyoming, a new publication now available for free distribution to the industry lists the boiling points, freezing points, densities, and refractive indices of more than 300 sulphur compounds.

The detrimental effects of sulphur in petroleum products have been recognized for more than a half century and refiners in general have avoided the use of such less desirable crudes; however, the increased demands for petroleum during and since the war coupled with the diminishing reserves of low-sulphur crudes, have caused more widespread use of high-sulphur crudes, the Bureau report points out.

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Plans are now being developed to install radio communication between the shore, the launch, and the tankers. At present it is planned to use the radio communications in addition to the telephone, with the radio to be used as a means of communicating with the launch before the telephone is connected and also to be used for loading operations in case of a telephone system failure. The telephone system is advantageous in that it can be operated by any crewman put on the job without training, and it is connected into the regular company telephone system on shore so that various departments and locations of the company can talk directly to the ship over the telephone.

Communication between the launch and the shore station at Ventura is the most important use required of the radio. Under present conditions once the launch has left Santa Barbara it cannot be contacted until reaching Ventura. The launch leaves Santa Barbara for Ventura 3 or 4 hr before the scheduled arrival of the tanker at Ventura. Often information is received by telegram from the tanker that it will be several hours late in arriving due to storms or other causes, but if the launch has left Santa Barbara, there are now no means available to communicate with it and have it return to Santa Barbara. In this way the launch and crew have a considerable amount of waiting or standby time that should not be necessary. Radio communication between launch and shore would also be an additional safety factor for the launch operator if any engine trouble or accident were to occur at sea on the trip between Santa Barbara and Ventura. At times the trip must be made during storms and rough seas.

● **Overhaul submarine line facilities.** The submarine pipe-line facilities are overhauled at two-year intervals at the present time. Formerly, the reconditioning work was an annual job, but reduced loadings and war conditions caused the change in schedule.

In order to conduct the overhaul, a derrick barge with the necessary equipment and crew is obtained. All replacement material and equipment that may be needed for the work are carried on the barge as there are no facilities available at Ventura to load heavy material from the shore to the barge, although small material can be delivered over the municipal wharf. One deep sea diver on the barge is sufficient for the necessary underwater work. Once the barge and crew arrive at the location, work is carried on from daylight to dark until the

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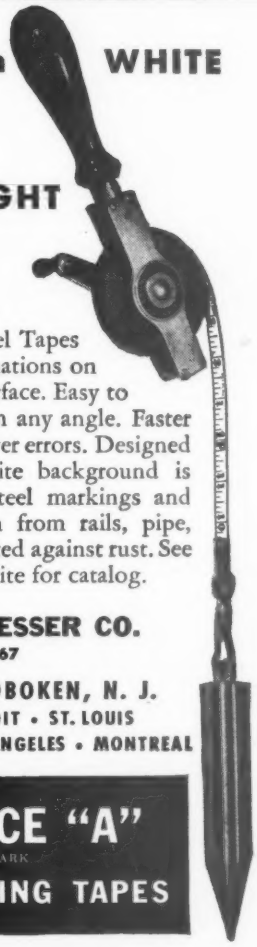

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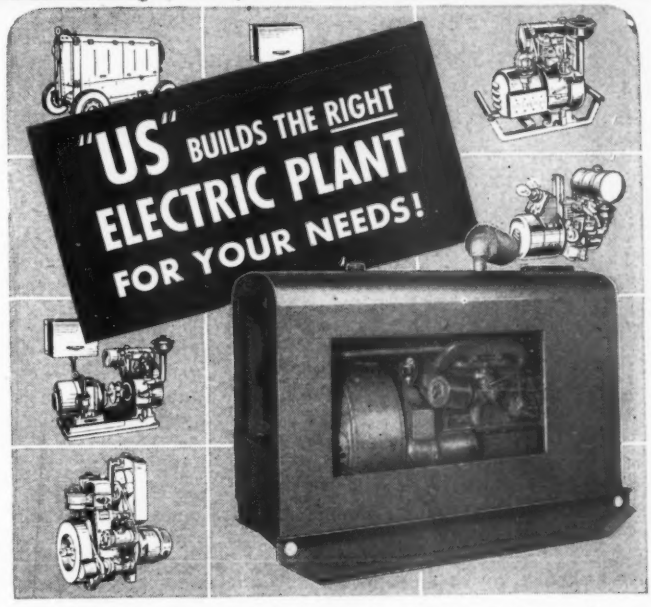

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job is completed. The work can usually be completed in five days.

All sections of the submarine hose are disconnected from the pipe line by the diver. The hose is placed on the deck of the barge and a thorough inspection is made of both the interior and exterior. If there are defects in any hose section, it is replaced with a good section that has been brought along for that purpose. The hose damage is usually caused by the hose being kinked or the hose being cut from the outside by an anchor or some other sharp object. The hose kinks can be caused by the ship dropping the hose after loading without stretching it out in the proper condition, or by raising the hose when the ship is not properly located. Any considerable amount of kinking of the hose will cause the steel reinforcing to break and it will often cut through the rubber walls of the hose.

The hose can be cut and damaged by raising the hose with the ship not properly located if the hose catches in the rudder or propeller of the ship. Difficulty has been experienced in the past with the anchors of fishing boats or other small craft hooking into the hose by accident. During overhaul operations any section of hose is replaced and discarded even though the defects are small, as the delays, repairs, and other damage that might result from a submarine line failure are very high.

The length of service for the submarine hose will vary considerably. For the 10-in. hose the maximum service obtained from any one section of hose has been five years and eight months, during which time 53,000,000 bbl of crude oil were pumped through the line; but the average life of the 10-in. hose has been 2½ years with 24,000,000 bbl of crude oil being handled during that time. The 8-in. gasoline hose is not used so frequently as the crude line, therefore, its life is longer. The maximum life of the 8-in. hose has been 11 years and 3 months, with 5,500,000 bbl of gasoline handled and this section of hose is still in use at the present time. The average length of service is 5½ years with 3,000,000 bbl of gasoline handled.

As part of the overhaul all mooring and marking buoys are taken out of the water and completely cleaned and inspected. All necessary repairs and replacements are made and the buoys are painted with anti-corrosive paint before being placed back in the water. The portion of the buoys showing above the water is painted with traffic line white paint over the anti-corrosive paint so that the buoys can be spotted easily from the ships.

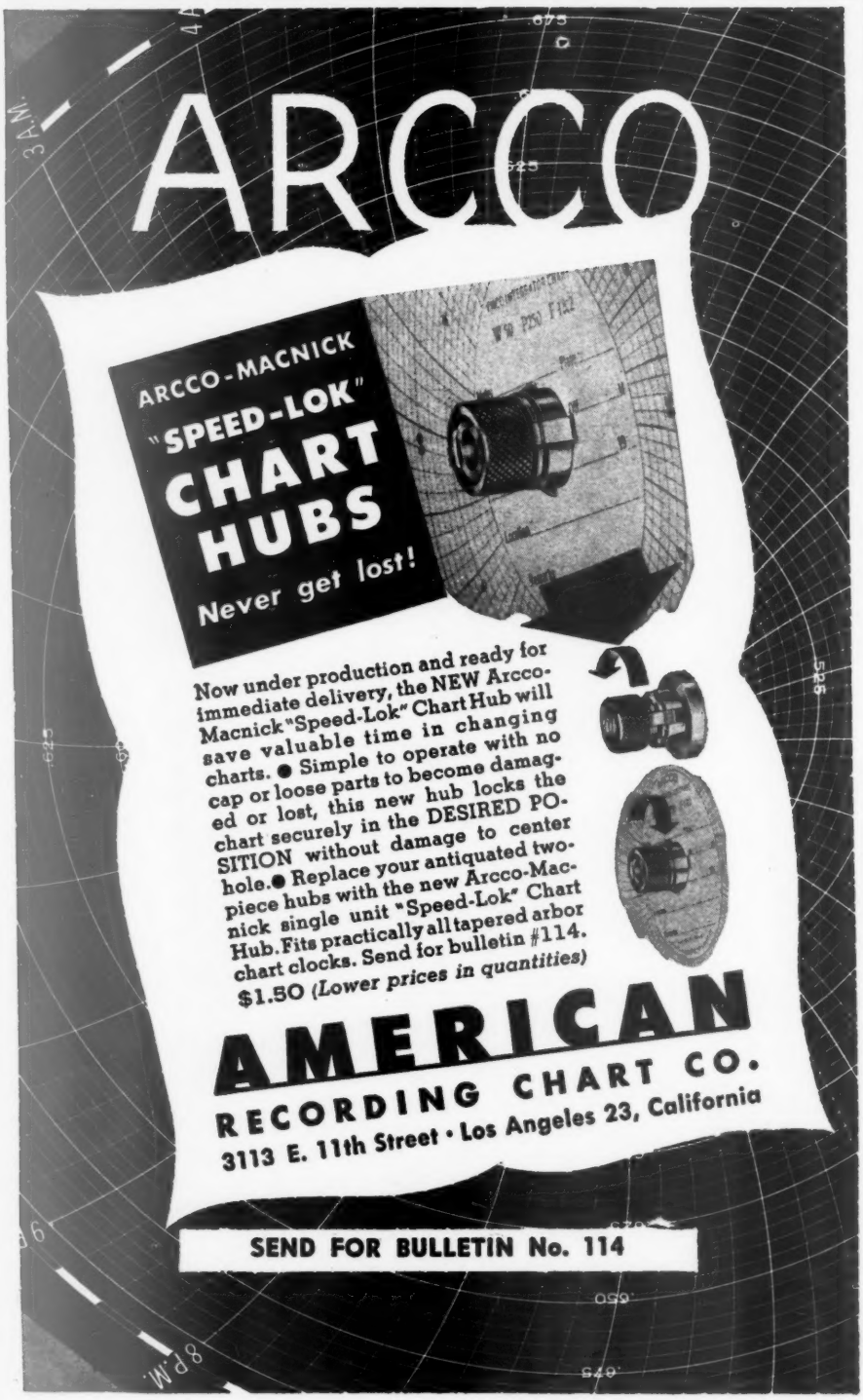
The anchor chains holding the buoys in place are pulled out of the water up to the dip section for inspection and renewal if necessary. The dip section, being that portion of the chain that works up and down continuously from the action of the waves and tide, is the only section of the chain on which there is much wear. The dip section, which is approximately 20 ft long for each chain at Ventura, is replaced during the overhaul work every two years, but the rest of the anchor chain is good for ten or more years.

No reconditioning work has been done on the submarine pipe lines under water. Inspection of the pipe has been attempted by a deep sea diver to determine the amount of external corrosion of the pipe, but this inspection cannot be made satisfactorily under water due to the pipe lines being covered with sand and making it necessary to jet the sand away to reach them. The diver's inspection report did indicate that the treating on the pipe was in fair condition.

No leaks have occurred in either of the present submarine pipe lines since they were installed but consideration is being given to installing cathodic protection to these lines. It is anticipated that the cathodic protection will reduce internal corrosion as well as external corrosion. Internal corrosion is prevalent in the submarine pipe lines, probably due to the action of the salt water that is placed in the lines when they are not in use.

So far as the submarine pipe-line operator is concerned, the two major problems are to see that no ship is delayed and to see that no oil gets into the sea. Failure to accomplish these objectives is expensive for the company. In order to accomplish these objectives, all equipment must be kept in good condition, and loading operators must be alert and careful at all times.

★ ★ ★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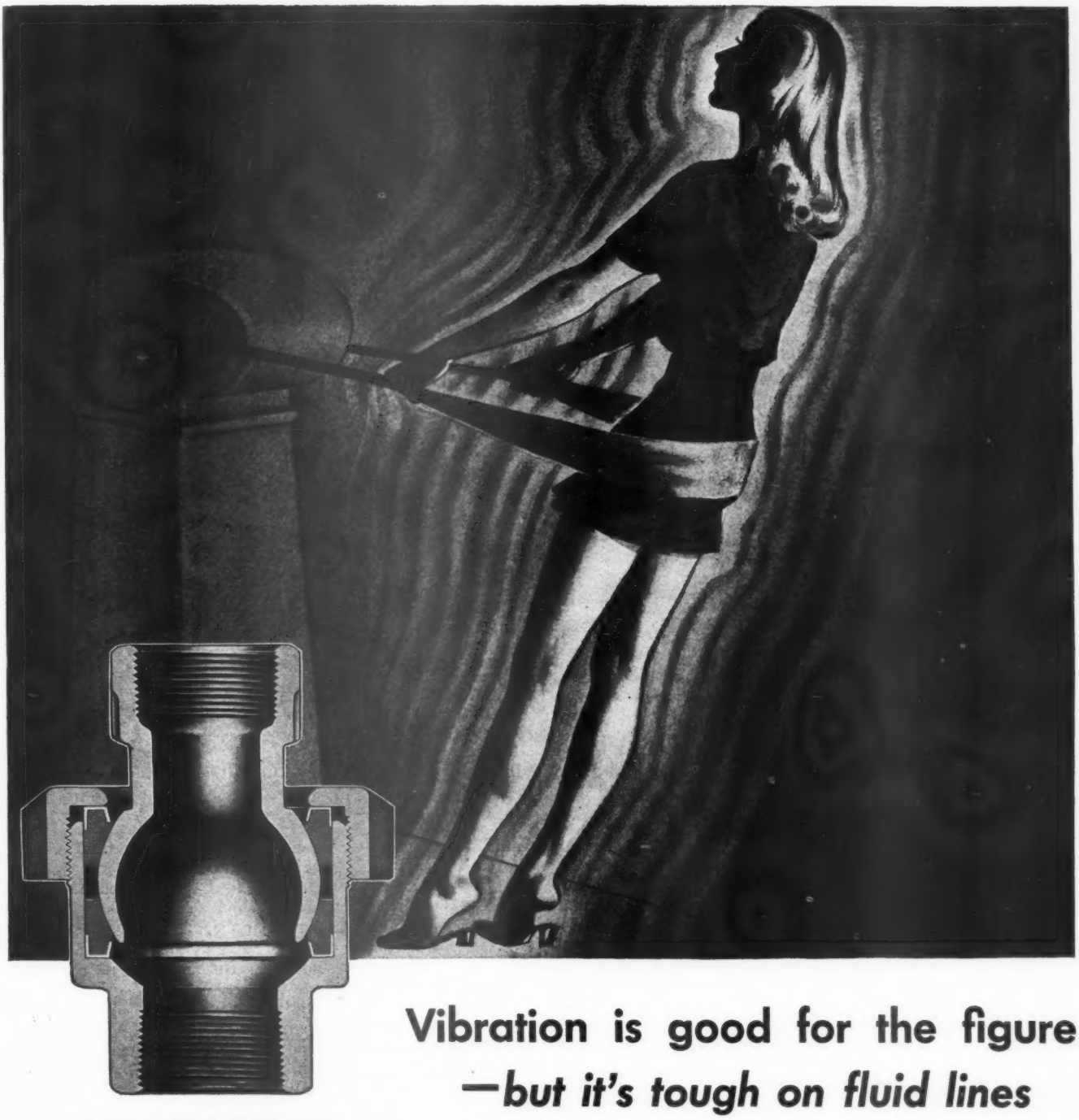

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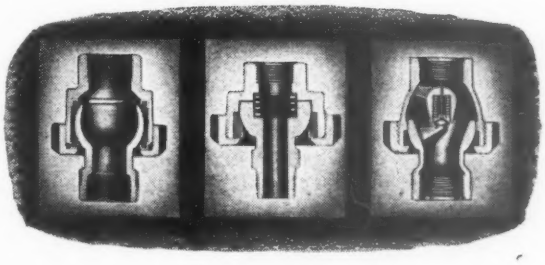

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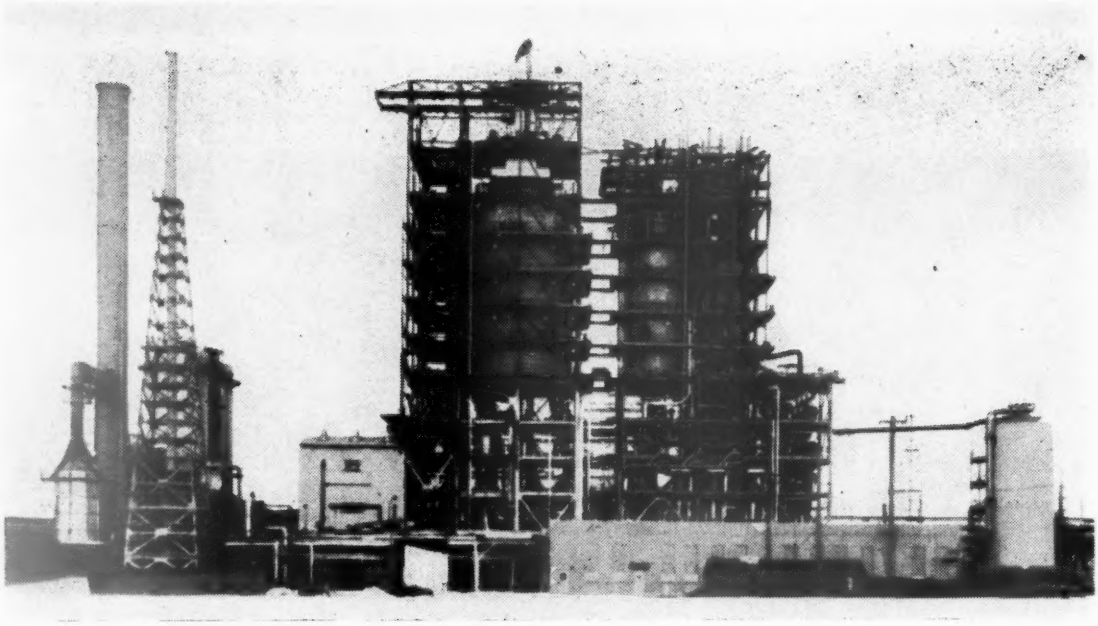

FIG. 1

Regeneration of spent catalyst in fluid catalytic cracking*

By **JOHN F. SNUGGS,** Research Department, Standard Oil Company (Indiana)

● **Abstract.** The factors that influence the design, operation, and control of spent catalyst regeneration facilities in commercial fluid catalytic cracking are discussed. The regeneration of spent cracking catalyst is accomplished by burning about 1 to 2 weight per cent of carbonaceous material from the catalyst under closely controlled operating conditions. During the combustion a large quantity of heat is produced. Regeneration supplies a portion of the heat required to support the reaction in the catalytic conversion zone, and excess heat is used to produce steam. A description of the facilities used for regeneration, and the integration of these facilities with the rest of the catalytic plant, is presented.

THE regeneration of spent catalyst by removal of carbonaceous deposit under closely controlled combustion conditions is an important feature of the fluid catalyst technique that has gained wide acceptance during the last six years. Regeneration is important not only because of the necessity for restoring catalyst activity, but also because of the large heat effects involved. In spite of the fact that only about 1 to 2 weight per cent of carbonaceous material is present on the catalyst, the combustion in the regenerator contributes a major portion of the heat required to support the conversion reaction taking place in the reaction section of the catalytic plant, and residual heat is usually used to make steam. The fluid catalyst type of operation is currently being used, or has been proposed for application, in many chemical and petroleum catalytic conversion processes where continuous, rather than intermittent, operation is desired. The most extensive application to date has been in the petroleum industry, where fluid catalytic cracking is now a well established process. Fluid catalytic cracking will be used as a basis in the following for discussion of regeneration design and practice.

*Presented at Spring Meeting, The American Society of Mechanical Engineers, Fuels Division, Tulsa, Oklahoma, March 2-5, 1947.

● **Description of process.** Description of the oil, air, and catalyst flows in the several types of fluid catalytic cracking systems have been presented in many papers published during the last few years. The general description that follows is a brief review for the purposes of the present paper.

The process equipment comprising a fluid catalyst unit can be divided into four principal sections:

1. Feed preheat section
2. Reaction section
3. Regeneration section
4. Product fractionation section.

Fig. 2 is a schematic drawing showing these sections and may be referred to in tracing the process flow.

In the feed preheat section fresh charging stock (gas, oil, etc.) is heated in tubular heat exchangers with hot streams from the fractionator and, in some cases, by means of an oil or gas fired furnace. Feed, either partially or completely vaporized, is directed to the regenerated catalyst pickup point where it contacts hot, finely divided, solid catalyst particles. This mixture of oil and catalyst flows upward into the reaction section where the cracking reaction takes place. A fluidized bed of catalyst is maintained in the reactor. Cracked vapors pass overhead from the reactor catalyst bed through cyclone separators, where all but a trace of catalyst is removed, and then these vapors enter the fractionation section. In this section products are separated according to desired boiling ranges and the small residual amount of catalyst is recovered for return to the catalytic system.

During the cracking reaction a catalyst deposit, or coke, is formed on the catalyst. This material must be removed in order to maintain catalyst activity and selectivity. To accomplish this regeneration, spent catalyst is continuously drawn from the reactor and is directed through a steam stripping zone where entrained and volatile hydrocarbons are removed, and is then caused to flow through a

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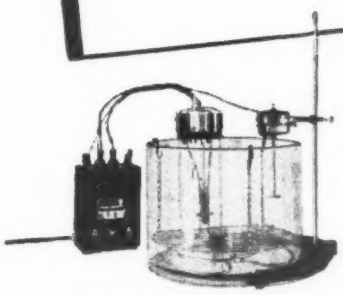

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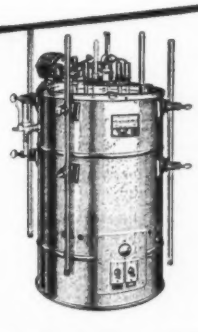

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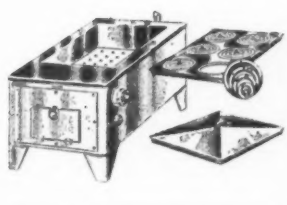

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standpipe. At the bottom of the spent catalyst standpipe the catalyst meets a stream of air that carries it into the regeneration section. A fluidized bed of catalyst is established within the regenerator, as in the reactor. The temperature of the burning that occurs within the regenerator is controlled by continuously drawing a stream of catalyst from the regenerator, cooling this material in a vertical tube exchanger, and returning cooled catalyst to the regenerator. Steam is produced in this recycle catalyst cooler; or, the heat may be used for heating process oil streams.

As the regeneration progresses, sufficient coke is burned from the catalyst to restore its activity, and the regenerated material is returned continuously to the cracking zone by means of another standpipe and the oil transfer system previously described. The gaseous combustion products of regeneration pass upward through the regenerator through catalyst recovery equipment and are then vented to the atmosphere. In many instances the flue gas leaving the regenerator passes through tubular boilers for additional heat recovery in the form of steam.

Fig. 1 is a view of a commercial fluid cracking unit showing the orientation of the principal sections of the equipment. Feed preheat exchangers are located to the right, the preheater furnace is at the left background. The smaller of the two vessels in the main structure is the reactor, the larger is the regenerator. The product oil fractionator and its auxiliaries are at the extreme right of the structure. Behind the catalytic structure and not visible in the picture are other structures housing the control room, regeneration air compressor, cracked gas compressors, and other auxiliaries.

● **Regeneration variables.** The principal variables affecting the design of a fluid catalyst regeneration system are:

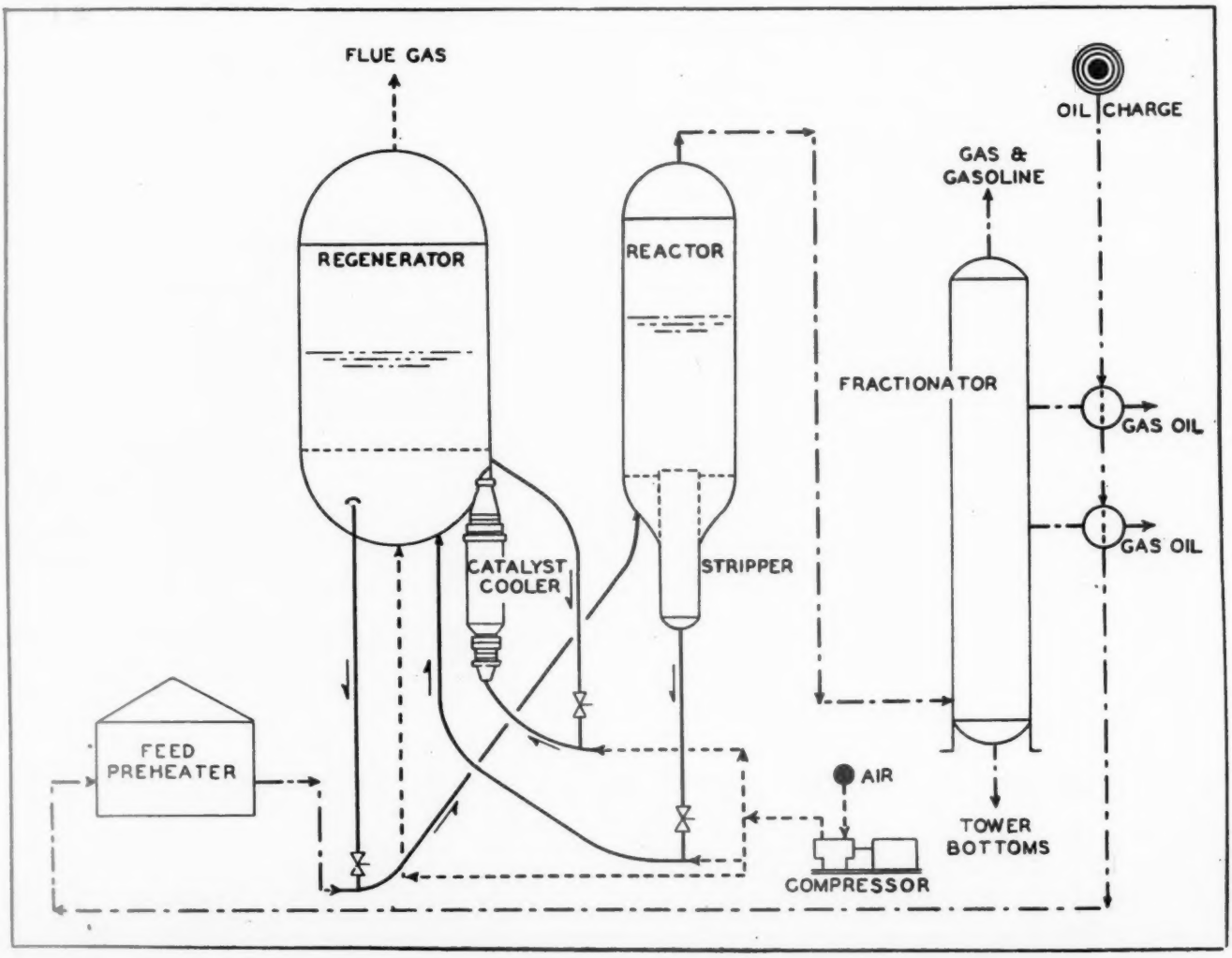
1. Temperature of regeneration.
2. Type of catalyst.
3. Analysis of catalyst deposit.
4. Fraction of catalyst deposit removed during regeneration.
5. Contact of air and catalyst and catalyst residence time.
6. Regeneration pressure.

These factors are discussed in general below.

● **Temperature of regeneration.** Commercial fluid catalytic cracking units operate with regeneration temperatures ranging from slightly below 1000 F to about 1200 F. The choice of operating temperature for design purposes is a balance between several factors. In general, the higher the temperature, the more readily the combustion occurs. On the other hand, at the highest temperature levels, permanent catalyst deactivation occurs at an accelerated rate, and construction problems and costs tend to become more important considerations. The type of catalyst to be employed is also to be considered, since some are more heat resistant as regards activity decline than others. Much study has been given these factors and their combined efforts have been evaluated, with the result that current designs generally call for a regeneration temperature falling within the 1025-1100 F range.

● **Type of catalyst.** As mentioned in the foregoing, the type of catalyst to be used affects the design and operation of regeneration equipment because of temperature deactivation problems. The catalyst type will also affect regeneration air requirements and heat evolution, since catalysts having different chemical compositions result in various ratios of CO_2 to CO in effluent regeneration gases. With various commercial catalysts the CO_2 to CO ratio varies between 50:50 to 65:35. The presence of certain metallic contaminants, such as iron, which may accumulate on the catalyst during operation, tends to increase the CO_2 to CO ratio, and results in increased air re-

FIG. 2



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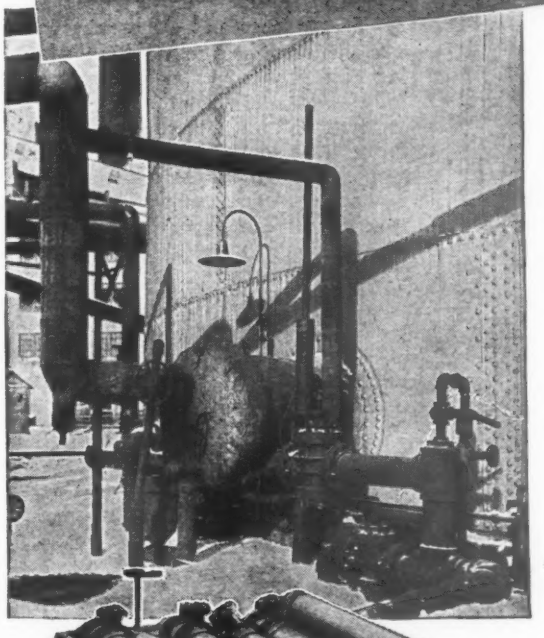

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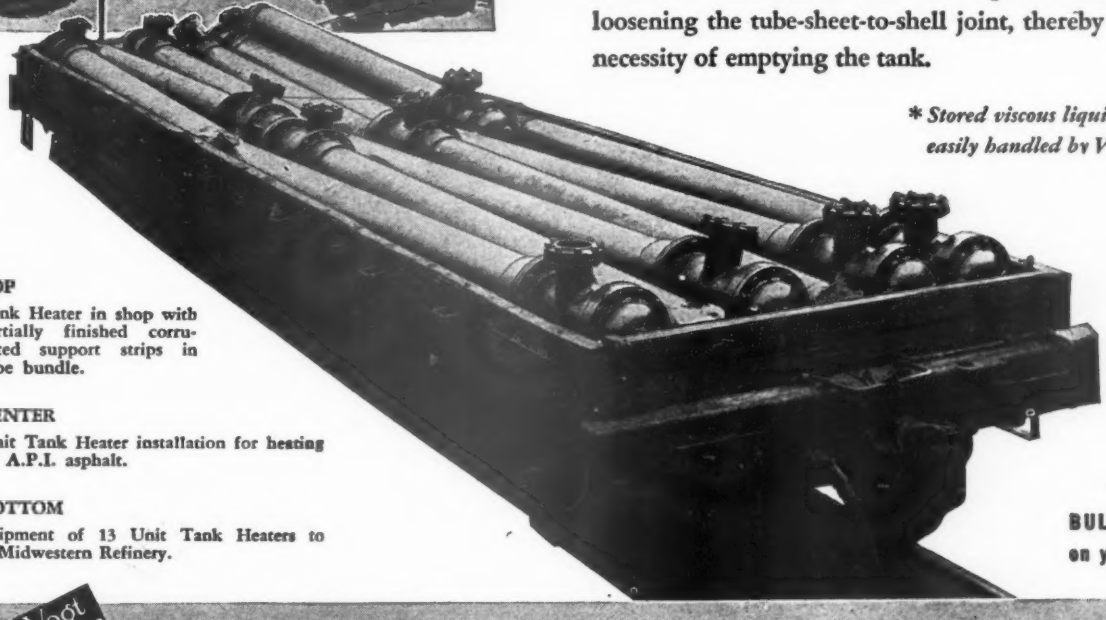

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quirements for burning of any given amount of catalyst deposit.

● **Analysis of catalyst deposit.** The coke, or catalyst deposit, which is to be removed from the catalyst during regeneration is composed principally of carbon and hydrogen, but may also include sulphur. The actual composition of the deposit is complex as regards hydrocarbon types and is not well known. Depending upon the adequacy of the spent catalyst steam stripping facilities, which are intended to remove entrained and volatile hydrocarbons leaving only coke, the carbon content of sulphur-free deposit varies from about 93 to 87 weight per cent and hydrocarbon content from about 7 to 13 weight per cent. (Hydrocarbon content calculated by nitrogen balance across the regenerator and determined by oxygen disappearance). As about four times as much air is required to burn one pound of hydrogen as is necessary for one pound of carbon, the importance of adequate spent catalyst stripping facilities and low hydrogen content in determining regeneration air requirements is obvious. Normally, with a well designed spent catalyst stripper, slightly less than 10 weight per cent of hydrogen in coke can be specified for design purposes. Heat of combustion and regeneration air requirements for various CO_2 to CO ratios and hydrogen contents are covered in a subsequent section.

● **Fraction of catalyst deposit removed during regeneration.** The weight per cent of catalyst deposit on spent catalyst charged to the regenerator varies between less than 1 to more than 2 per cent in commercial installations and is partially a function of the catalyst-to-oil ratio fed to the cracking zone. Regenerated catalyst contains from about 0.3 to 1.0 weight per cent of residual deposit after completion of combustion. A balance between several factors defines the coke level desired on regenerated and spent catalyst for any specific design. First, the burning of one pound of coke from catalyst having a high deposit content generally proceeds more readily than the burning of the same amount of coke from catalyst having a low coke content. Second, it is desirable from the standpoint of the cracking reaction side of the process to maintain a relatively low catalyst carbon content. Third, high coke percentages on catalyst in the regenerator are not satisfactory, since catalyst entrainment in flue gas tends to become an increasingly important factor. In commercial operation, balancing between these factors has established the desirability of maintaining coke content of regenerated catalyst at between about 0.3 and 0.7 weight per cent by control of other operating variables.

● **Contact of air and catalyst and catalyst residence time.** One of the more important factors affecting the economical utilization of regeneration air is the provision of a suitable distribution device to promote adequate contacting of air and catalyst within the regenerator. Distribution of air, typically, is accomplished by means of a grid plate located at the bottom of the regenerator catalyst bed. This grid contains many small diameter holes and imposes 0.5 to 1.0 pounds pressure drop to the air flow. It is also desirable to avoid a shallow catalyst bed within the regenerator through which mass channeling of air may occur. In large commercial units, at least 10 ft and preferably 15 ft of regenerator bed depth are desired when the regenerator takes the form of a single bed.

Gas should flow through the regenerator at low velocity. Commercial designs call for about 1.5 fps velocity, which is satisfactory from the standpoint of minimizing catalyst entrainment in the gas.

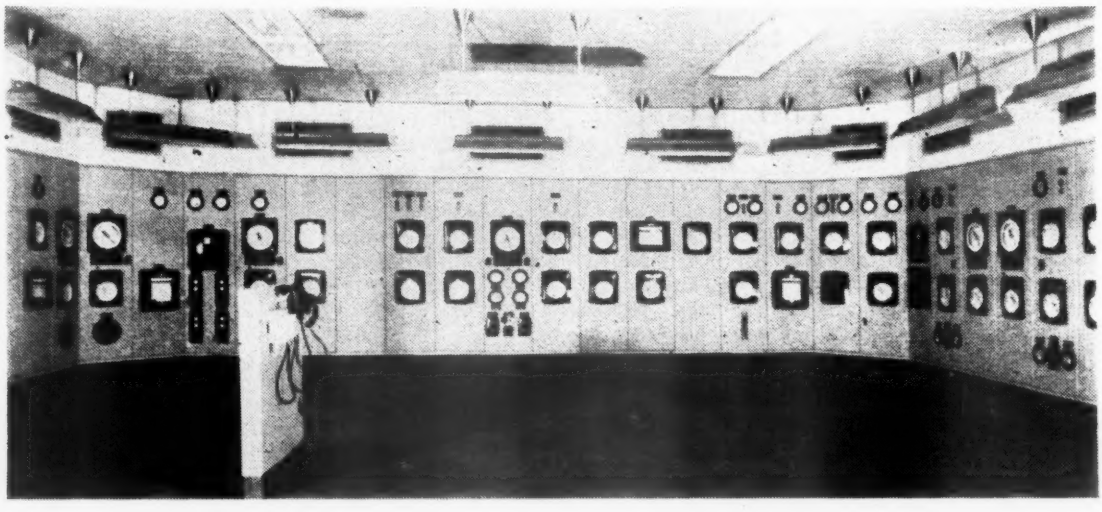
The residence time of catalyst within the regenerator has been varied over exceedingly wide ranges in test work on commercial units. With good distribution of air there appears to be no appreciable incentive for extending the residence time beyond five minutes when attempting to control to approximately 0.5 weight per cent carbon on regenerated catalyst. Because of the effect of other necessary design factors (required bed depth for proper air distribution, maximum allowable gas velocity in regenerator, etc.) the residence time ordinarily exceeds this minimum value and ranges between ten and twenty minutes.

● **Regeneration pressure.** Commercial fluid cracking unit regenerators operate with pressures at the tops of the vessels ranging between about 1 and 13 psig. Obviously, with specified maximum allowable gas velocities within the regenerators, the higher pressures permit smaller diameter vessels in new designs, or greater air flows in existing units. It has been shown that the combination of catalyst deposit proceeds more favorably at the high pressure levels. The choice of pressure used weighs these factors and others against the increased cost of compressing large amounts of air to the higher pressure levels.

● **Heat release and air requirements.** The amount of heat released in the burning of carbonaceous material transferred with catalyst from the reactor to the regenerator is influenced by the several factors that control regeneration operation. For design purposes, the amount of heat released per pound of catalyst deposit burned can be calculated from the expected flue gas analysis, hydrogen content of coke, etc., each of which follows the general concepts mentioned above under "Regeneration Variables." Table 1 summarizes net heat of combustion values for several possible conditions.

It is to be noted that the weight per cent of hydrogen in catalyst deposit is designated as that amount determined by oxygen disappearance calculations based on Orsat analyses and nitrogen balance. Oxygen is probably also consumed in the regenerator oxidizing metallic impurities that are in the catalyst. In some cases account is taken of this factor, but in most instances it is neglected due to lack of specific knowledge as to the magnitude of the adjustment to be applied.

Net heat of combustion values are used in establishing an overall heat balance around the regeneration system. The amount of heat that must be removed in the form of steam is determined



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by difference after determining the amount of heat transferred to the reaction zone due to the rise in catalyst temperature in passing through the regenerator and the net heat leaving the regenerator in combustion gas. As an example of the distribution of combustion heat in a specific commercial unit, which will be discussed in more detail later, the data of Table 2 are presented. In this unit, construction and design details are such that approximately 53 per cent of the heat released in burning is recovered in recycle catalyst coolers as steam. In other types of design as much as 65 or 70 per cent of the heat is recovered in producing steam; in some, no heat is recovered in the form of steam, control of the regeneration system being obtained by absorbing in the reactor system all heat recoverable from catalyst.

Combustion air requirements for the regeneration operation are affected by all factors which influence dry flue gas composition, by the hydrogen content of catalyst deposit, and by the oxygen content of effluent flue gas required for control. Table 3 summarizes air requirements calculated for various ratios of CO_2/CO in flue gas, various hydrogen contents of the coke, and for 2 per cent oxygen in flue gas. Actual practice confirms closely the stoichiometrically calculated requirements.

TABLE I. Heat of combustion of catalyst deposit in fluid catalytic cracking.

Ratio CO_2/CO in combustion gas	Weight per cent of hydrogen in catalyst deposit*	Net heat of combustion of deposit burned from catalyst—Btu/lb deposit
50:50	8	12,440
65:35	8	13,840
50:50	12	14,140
65:35	12	15,480

Basis

Reaction	Net heat of combustion Btu/lb of H or C
$H+\frac{1}{4}\ O_2 \rightarrow \frac{1}{2}\ H_2O$	51,650
$C+O_2 \rightarrow CO_2$	14,100
$C+\frac{1}{2}\ O_2 \rightarrow CO$	3,960

*Measured by oxygen disappearance in regenerator as determined from Orsat analysis and nitrogen balance.

TABLE 2. Distribution of regeneration heat in a commercial fluid catalytic cracking unit.

	Millions of Btu/hr	Per cent
Heat released	238	100
Heat in flue gas (over entering air)*	56	23
Heat to reaction zone	36	15
Heat to steam	125	53
Heat loss and unaccounted for	21	9
Total	238	100

Basis

Operations shown in Table 4.

Net heat of combustion of coke is 13,840 Btu/lb at 8 per cent hydrogen.

Reaction zone at 900 F.

Steam produced at 160 psig from 300 F boiler and feed water.

*Approximately 50 per cent of this heat potentially recoverable in a flue gas boiler, bringing steam to 153 millions of Btu/hr or 64 per cent of heat release.

TABLE 3. Combustion air requirements in fluid catalytic cracking

Ratio CO_2/CO in combustion gas	Weight per cent hydrogen in catalyst deposit*	Combustion air requirement, lb air/lb deposit burned
50:50	8	12.05
65:35	8	12.92
50:50	12	13.18
65:35	12	14.02

Basis

2 per cent oxygen in dry effluent flue gas.

Air supplied at 100 F, 50 per cent relative humidity.

*Measured by oxygen disappearance in regenerator as determined from Orsat analysis and nitrogen balance.

TABLE 4. Regenerator operation in a fluid catalytic cracking unit.

Design details	
Vessel diameter	36 ft-6 in ID
Shell length	40 ft
Heads	Hemispherical
Top elevation	150 ft
Shell and heads	Carbon steel
Operating conditions	
Pressure at top of vessel	9 psig
Catalyst bed temperature	1025 F
Entering air temperature	230 F
Catalyst bed depth	18 ft
Catalyst bed density	20 lb/cu ft
Spent catalyst charge	540 tons/hr
Air supplied	220,000 lb/hr
Gas velocity at top of vessel	1.45 ft/sec
Carbon on spent catalyst	1.80 weight per cent
Carbon on regenerated catalyst	0.35 weight per cent
Coke burned (8 per cent hydrogen)	17,200 lb/hr
Flue gas analysis (dry)	
CO_2	12.0 volume per cent
O_2	2.0 volume per cent
CO	5.8 volume per cent
Inert	80.2 volume per cent
Steam produced	135,000 lb/hr

● **Control of regeneration.** Many variations in regeneration control technique have been used in fluid catalytic cracking units. The system described in the following is typical of practice used in several instances.

The flow of spent catalyst from the spent catalyst standpipe, and the consequent load imposed upon regeneration facilities, is regulated by means of a slide valve. The opening of the valve is automatically controlled by positioners which are controlled by the level of catalyst in the reactor. A specified catalyst level is maintained in the reactor so that cracking severity, and coke production, are maintained constant.

The air used to transport catalyst from the bottom of the spent catalyst standpipe to the regenerator is flow controlled at the quantity that will give suitable flow characteristics and maintain satisfactorily low burning rate in the carrier line. Additional combustion air enters the regeneration zone through the recycle catalyst cooler system and through auxiliary air lines. Each of these flows is also controlled at desired rates. The speed of the air compressor supplying combustion air is regulated by a controller that gives constant pressure at the discharge of the machine.

☆ ☆ ☆ ☆

Farm and fish oils now can be refined cheaply as a result of a new solvent process using propane gas—which means more good soap, quick-drying paint, more dressings for salads, and more vitamins for the diet.

Temperature in the regenerator catalyst bed is maintained at a specified level by circulating hot catalyst through a standpipe, through a cooler, and then back to the regenerator. The rate of catalyst circulation through the cooler is automatically regulated by temperature controllers that actuate slide valve positioners. Two circulating loops are used on large units. The boiler feed water and steam systems appurtenant to the recycle coolers are ordinarily automatically controlled.

In regeneration operations it is possible under certain conditions for the carbon monoxide formed during the combustion to burn to carbon dioxide near the top section of the vessel, where catalyst concentration is low. When this occurs, very high temperatures result. In order to protect the regeneration equipment, use is made of emergency water sprays, which are directed into the burning gas and, at times, into the catalyst bed. Flow of emergency spray water is controlled to the desired quantity while steps are taken to eliminate the factors leading to the upset condition.

The pressure at the outlet of the regenerator may be automatically or manually controlled. In case of automatic control, a pressure tap at the top of the regenerator is the control point for a valve positioner which adjusts the opening of a valve throttling the flue gas flow.

For economical use of combustion air, it is desirable to maintain only a slight excess of oxygen in the regenerator flue gas. A visual record of oxygen content of this stream is obtained in many units by means of an oxygen recorder that samples at the regenerator outlet. As a further check upon operations, samples of flue gas are regularly obtained for determination of carbon dioxide, oxygen, carbon monoxide, and inerts by Orsat analysis.

Fig. 3 is a view of a control panel where the principal instruments used in connection with the regeneration facilities are grouped. In addition to the controllers, recorders, and indicating devices shown, supplementary instruments are located elsewhere for control of the air compressor, recycle catalyst cooler feed water system, and other auxiliaries.

● **Commercial regeneration operating data.** Table 4 summarizes some design and operating data for a commercial fluid cracking unit regenerator. It is to be emphasized that this tabulation illustrates operation of a specific installation and that the data are not typical for all units. For other units, in addition to variations in design details, the operating conditions may differ considerably from those shown. The unit under consideration is an installation designed for low catalyst circulation rate between the reactor and regenerator and for moderate regeneration temperature, and has a recycle catalyst color for control of regeneration heat balance. ★ ★

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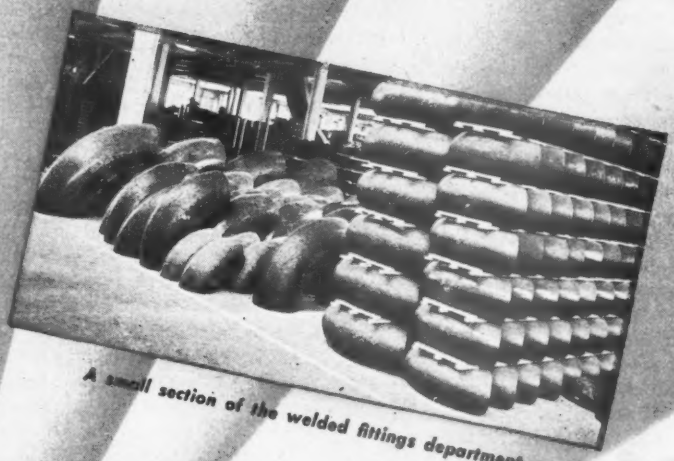

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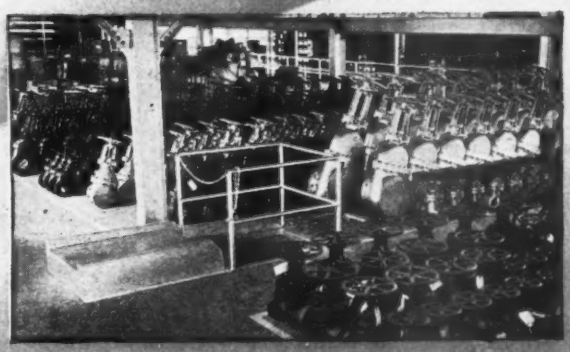

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The oil compact

By **ERNESTINE ADAMS,** *Associate Editor*

EXCLUSIVE

THE United States oil industry 12 years ago combined with local state governments to develop a form of nation-wide cooperation under the Interstate Oil Compact that offers a well-tested framework for other industries and even presents a study for economic alliances among other political entities. It is a formation of economic and political factors that harmonize with the American practice of free enterprise. It is another proof that enlightenment and experience tied to reasonable freedom of action continues to be the most dependable and efficient machinery for effective cooperation in the industry so far conceived.

In the years from 1930 to 1935, when overproduction shook the economic substructure of the nation, no one item was in greater volume than crude oil. Paradoxically, the bonanza East Texas and Oklahoma City fields brought poverty to the oil industry. In the big fields oil slid to 10 cents a barrel; over the nation the average went to 18 cents.

Why then did the federal government not take over control, name a bureau, put a floor under crude oil prices, and subsidize operators as it did in many other similar cases during those dark days? The answer to that is—the Interstate Oil Compact.

Instead of running to Uncle Sam for money and solace, the oil men themselves tackled the tough fishing job that finally brought a solution to the surface. They did it primarily because they didn't like the idea of Uncle Sam telling them how to run their business. But to keep Uncle Sam off, they had to do a better job than ever before in holding supply to demand and in keeping plenty of reserves for emergencies.

Administrations of states that produced oil were quite as eager as the industry to discover a means whereby the states could regulate their own resources of hydrocarbons instead of having the federal government take charge.

This was during a period, however, when the pressure for federal control of national resources was at full force. Herds of voters wanted to put everything into the hands of the popular national administration. Powerful executive officers reached out to grasp the authority loosed by Congress and the public. The then secretary of the interior consistently favored federal control of the oil industry. He held that state control would fail and oil operators expected it to fail.

On one side was the eagerness of the U. S. executive department for control and the demands of a frightened electorate that the national administration manage the economy of the country. On the other side was an industry beset by a flood of oil from new discoveries and torn by sharp and wide differences among its many groups. Agreements were so small and feeble that any consolidated action appeared hopeless. The stout cable that finally hauled out the compact was the steel determination of every group that the federal government wasn't going to control their industry.

Self-interest was, of course, at the bottom of this movement that grew into the Interstate Oil Compact, but it was a self-interest that found it paid to learn all possible facts, to judge after careful study the best course to follow, and to let the whole industry—and the public too, if it wished—know what was done and what were the results.

The oil industry probably understood better than any other business group the potential danger that might lurk in the girders of federal control. Its members had dealt with government ownership of oil operations in other countries and had witnessed the stagnation that followed in the tracks of government management. They understood at the same time that public demand would force them into federal control in the United States if they didn't work out their own problems. They might be paid for oil that wasn't produced, as cotton farmers were being paid for plowing up every third row of cotton, but eventually they would lose their privilege, and with it their ability, to develop a free competitive national and international market and to profit by it.

The industry was fearful of its existence as a free enterprise; the state governments were jealous of their authority. No matter how the motive is appraised, the American public won the greatest benefits in the formation of the state-industry coalition whose stated purpose was to conserve oil and gas.

When first proposed the altruistic ideal of petroleum conservation was met with a flow of protest from all sides. Oil was pouring prodigally from the earth and demand was thin as rainbows on a slush pit. There was more oil than anybody could ever use and who wanted to conserve oil at 10 cents a barrel? Water cost more in some places.

The disagreements were many and varied. In the meetings that were held it often appeared there was no way out except to toss the whole business into the waiting hands of the secretary of the interior. Even a loosely formed associaton became no more than a hope. There were not only the differences among the committees from oil associations but the oil state governors and their representatives who attended the informal gatherings represented vast political differences that were reflected in economic conceptions.

That they finally accomplished their purpose is due to both the operators and the state officials. It would be hard indeed to set a value on the contributions of either to the final organization. Some, like the late Governor E. W. Marland of Oklahoma, were experienced oil men and also held political posts. The high degree of patience and abundance of effort expended in the five years before the compact was executed was only the beginning. In the 12 years since, the members who have continued to stick doggedly to their goal could give the United Nations pointers on handling tough problems.

When the Interstate Compact to Conserve Oil and Gas was finally executed February 15, 1935, in Dallas, Texas, the agreement provided that oil-producing states should join together for the purpose of conserving petroleum through prevention of physical waste and should enact laws to further that purpose. Each member state was to have one representative on the Interstate Oil Compact Commission, a body that was to study methods and practice in conservation of oil and gas, to report its findings, and to recommend procedure for improvement to the states.

After all the struggle of forming the compact, out of 11 states that approved the brief terms and provisions, the legislatures of only six states agreed immediately to abide by them. New Mexico, Oklahoma, Kansas, Colorado, Texas, and Illinois legislatures ratified the compact in the order named.

The compact, as executed, probably had less power than any other organization of such scope in history. Either with child-like trust or great wisdom, the compact accepted a tremendous responsibility in its objective of conservation but it took upon itself no authority that would enable it to punish those states that refused to join or, joining, did not comply with its terms.

Compacts between states are older than the Constitution and they have been used by various states for a number of reasons, such as determining boundary lines, but no continuing program such as petroleum conservation had been built on this framework. Congress must approve all compacts and in the case of the Interstate Oil Compact for Conservation of Oil and Gas, approval was readily granted after President Roosevelt decided it was worth trying.

After 12 years the time has arrived to judge how it has worked—this lightly bound group that leaves its members

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self-regulating and independent. Like all successful relationships of this type there are endless ramifications—some vague, some vivid—that have fused to create the steady machinery of the compact. There is nothing spectacular about the organization and for that reason it has not been fully appreciated by the uninformed. It works effectively and intelligently, using the process of free discussion, weighed decision, and responsible execution to fulfill its function.

First, although the oil compact has no power to force states to join, there are 18 (Tennessee has just joined) oil-producing states instead of the original six in the present membership and no state has ever resigned. One state, Georgia, is an associate member, having oil exploration activity but no production. A bill in the Indiana legislature is ready for passage to bring the total membership to 19 states. Present members are: Alabama, Arkansas, Colorado, Florida, Illinois, Kansas, Kentucky, Louisiana, Michigan, Montana, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Texas, West Virginia, and Tennessee.

With the exception of California, nonmembers have relatively minor oil production. These include Mississippi, Missouri, Nebraska, Virginia, and Wyoming. Another year or so may see these states, too, in the compact. Even now they send observers to the quarterly meetings and voluntarily follow the recommendations just as members do.

Second, the compact has no authority to decide the laws on operation and regulation of oil and gas production that member states should set up. All the member states, however, and others outside and even foreign countries have conservation laws based on those prepared by the compact's legal committee. Not because they had to, but because the studies of the experienced committee members have outlined the best set of petroleum conservation laws available, and it is kept up-to-date by continual investigation and improvements to fit constant changes in oil operations.

The compact also has no direct machinery to enforce any rules adopted but studies and recommendations of Compact committees devoted to regulatory practices, research and coordinating, engineering, etc., are followed more closely than many laws with fines and imprisonment to back them up. Genuine analyses and frank reports have proved more forceful than an army for the industry. Oil-producing states follow enlightened direction in complete self-interest yet have the warming knowledge that the whole nation is benefited by their action.

Fourth, the compact cannot collect dues from its member to carry out its functions. As every survey undertaken by the organization requires money and every state already has too many obligations that demand funds, it might seem a serious deterrent, but it has not proved to be. The states have voluntarily allotted ample sums to carry on the work.

Still more important than the money, the states and the oil industry have enlisted the aid of eminent scientists and technicians to study and report to the compact on problems that arise in the quest for efficiency in the conservation of petroleum. The compact offers these men, who have already attained leadership in their chosen field, an opportunity for promotion of sound reform in the industry without the political limelight that floods Washington meetings of economic-political significance. Outstanding men of the industry have shown themselves very willing to give invaluable time and effort to advancement of the organization's work.

The federal government assists the compact by preventing interstate commerce of oil and gas and products of these that are produced in violation of state laws; by supplying information on supply and demand through the Bureau of Mines, and by controlling imports.

To understand the way the compact operates it might be well to review some of the events of the last quarterly meeting. Attending, as usual, were a number of the governors as well as their representatives of each member state and many of the great men of the industry. With open discussion and planning between the state regulatory bodies and the industry there is little room for misunderstanding and no place for ineptitude.

As an example of the subjects covered, one of the reports by the Research and Coordinating Committee was a survey on secondary recovery activities. This was the outcome of a strong plea for greater stress on secondary recovery made at a previous meeting by Don T. Andrus, an oil operator and Pennsylvania compact representative. He estimated 100 billion barrels of oil in old fields were not recoverable by present methods of production. Research in this problem had not been pushed during busy war years but now the compact is pursuing the study, which is highly important to the industry and the nation.

In the report by the committee, actual operations in the various states had been examined and were described by method and results so that others could go on from there with good foundation for further experimentation. More research projects were recommended by the committee and it is safe to say more research projects on secondary recovery will be carried out in the future because of this report.

Here is a problem that, if successfully worked out, will add many billions of barrels of reserves to the present 22 billion of the United States, probably the most important natural resource of our nation. There will be no cost to the United States taxpayer for the actual research performed by the industry and for the gathering and publicizing of information by the compact. There is strong reason to expect ultimate major progress in accomplishing economic efficiency in secondary recovery methods. The combination of industry and states has proved its effectiveness too well in past undertakings to be much doubted.

This is a sample of the studies that are made and are brought before the compact. The meetings also include a review of the oil activities of each state, reports from each committee on its studies, and a forum for examination of any common problem confronting the whole industry. This open discussion sparks the interest that considers exhaustively such questions as residue gas conservation, unitization of oil field operations, state-wide gas proration, etc.

The important thing is this: Here is a great and essential industry, unhampered by detailed overall control, working out its problems on the historical and extremely effective town hall system. It has compromised endlessly in arriving at a mutually agreeable compact but it has not compromised in the vital issue of seeking the truth and convincingly publicizing it so that operators have been ready to carry out compact recommendations intelligently.

The compact has undoubtedly been healthy for the oil industry but that is minor indeed if it has not been successful for the nation as a whole.

In both world wars it would be hard to name an industry that contributed more with less fuss. In the postwar period the United States oil industry is supplying the highest peacetime demand for oil products in history at less cost adjusted to expense than ever before. Its exports, though not so large as during Lend-Lease, are still greater than before the war. Available proved resources below ground are larger than they have ever been and above ground stocks are abundant. Not only has the nation been supplied with ample petroleum products at low cost in present times of virtual inflation but the government was not forced to support prices in depression times as it did in other industries, and for war production the industry itself supplied a large proportion of capital for expansion, saving great sums for the government and ultimately for the U. S. taxpayer. National control has never, in the history of the world, maintained so effectively the balance between supply and demand and conservation.

(There is little point, however, in comparing the United States oil industry with that of any other nation because there are none on comparable terms.)

The basis for this efficient production and supply lies with the operations of the Interstate Oil Compact whose sole authority has been derived from the honesty of its purpose and the willingness of its members to point the way with the bright lights of facts and research and study.

The public can be confident it will be served most reliably by the interstate system. Indeed, the effectiveness of the compact recommends it as a worthy study to all those who are organizers in one way or another, whether it be for industry, for political units, or for both.

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Petroleum reserves brought up to date

THE continental United States has proved liquid hydrocarbon reserves of 24,194,587,000 bbl and proved natural gas reserves of 160.6 trillion cu ft, as of December 31, 1946.

This was disclosed in a joint report of the committees on reserves of the American Petroleum Institute and the American Gas Association, marking a new method of estimating the nation's petroleum resources and the first time the reports have been issued jointly.

Of the total liquid hydrocarbon reserves, 20,873,560,000 bbl are crude oil, the committees reported, and 3,321,027,000 bbl are natural gas liquids. Similar figures for the year previous are not available, but Table 1 shows that crude oil reserves increased 931,714,000 bbl, or approximately 5 per cent.

TABLE 1

	Dec. 31, 1945, bbl	Dec. 31, 1946, bbl
API crude oil reserves	19,941,846,000	20,873,560,000
API condensate reserves	884,967,000	1,050,794,000
Additional natural gas liquids reserves	(not available)	2,270,233,000
Total reported liquid hydrocarbon reserves	(not available)	24,194,587,000

(Natural gas liquids include condensate, natural gasoline, and liquefied petroleum gases.)

Proved natural gas reserves of 160.6 trillion cu ft increased 12.8 trillion cu ft from the December 31, 1945, total of 147.8 trillion, or about 8 per cent for the year. The estimated net production of natural gas for the year of 1946 is 4.9 trillion cu ft after deducting the amount of gas returned to reservoirs.

The improved estimating procedure was developed by the two committees in an effort to reach a more accurate conclusion and to present a more accurate appraisal of the nation's proved petroleum resources.

TABLE 2

(Bbl of 42 U. S. gal.)

Total proved reserves of crude oil (exclusive of 884,967,000 bbl of condensate) as of December 31, 1945, bbl		19,941,846,000
Revisions of previous estimates, bbl	+1,254,705,000	
Extensions of old pools, bbl	1,158,923,000	
New reserves (new pools) discovered in 1946, bbl	244,434,000	2,658,062,000
Total proved reserves as of December 31, 1945, and new proved reserves added in 1946, bbl		22,599,908,000
Subtract production during 1946, bbl		1,726,348,000
Total proved reserves of crude oil as of December 31, 1946, bbl		20,873,560,000
Increase in crude reserves since December 31, 1945, bbl		931,714,000

In previous years, the American Petroleum Institute estimated the reserves of liquid hydrocarbons in the United States, which included all the crude oil and the condensate portions of the natural gas liquids. This year, the Institute and the American Gas Association divided the work into crude oil reserves, estimated by the Institute, and natural gas reserves with their contained liquids, estimated principally by the American Gas Association, assisted by the API.

"The estimates in this report," the committee said, "as in all previous reports, refer solely to proved or blocked-out reserves. They include only oil and gas recoverable under existing economic and operating conditions." ★★★

TABLE 3. Estimated proved reserves in the United States.

(Bbl of 42 U. S. gal.)

	Estimates of proved reserves of crude oil plus condensate (Dec. 31, 1945) as indicated in committee's report of Feb., 1946	Proved reserves of crude oil (condensate not included)				
		Proved reserves as of Dec. 31, 1945	Changes in proved reserves due to extensions (new oil) and revisions during 1946	Proved reserves in new pools discovered in 1946*	Production during 1946	Proved reserves as of Dec. 31, 1946 (cols 2+3+4 less col 5)
	(1)	(2)	(3)	(4)	(5)	(6)
Alabama	785,000	785,000	109,000	..	382,000	512,000
Arkansas	303,674,000	287,623,000	4,172,000	1,764,000	26,501,000	267,058,000
California	3,409,948,000	3,318,006,000	276,787,000	13,876,000	315,178,000	3,293,491,000
Colorado	259,830,000	259,830,000	51,265,000	800,000	12,025,000	299,870,000
Illinois	349,620,000	349,620,000	72,452,000	4,606,000	75,414,000	351,264,000
Indiana	41,243,000	41,243,000	7,878,000	1,633,000	6,684,000	44,070,000
Kansas	541,846,000	541,846,000	87,319,000	12,629,000	96,478,000	545,316,000
Kentucky	56,721,000	56,721,000	13,066,000	88,000	10,687,000	59,188,000
Louisiana	1,689,781,000	1,558,891,000	207,018,000	25,857,000	139,969,000	1,651,797,000
Michigan	64,186,000	64,186,000	21,576,000	415,000	17,000,000	69,177,000
Mississippi	267,160,000	257,363,000	34,939,000	1,790,000	23,871,000	270,221,000
Montana	108,474,000	108,474,000	2,576,000	2,000,000	8,804,000	104,246,000
Nebraska	500,000	500,000	665,000	..	290,000	875,000
New Mexico	512,373,000	512,373,000	65,000,000	2,871,000	36,791,000	543,453,000
New York	81,189,000	81,189,000	..	..	4,900,000	76,289,000
Ohio	29,681,000	29,681,000	3,047,000	..	3,508,000	29,220,000
Oklahoma	889,839,000	888,839,000	98,423,000	47,731,000	136,807,000	898,186,000
Pennsylvania	110,601,000	110,601,000	..	..	13,100,000	97,501,000
Texas	11,470,294,000	10,835,257,000	1,441,158,000	126,594,000	756,649,000	11,646,360,000
West Virginia	38,630,000	38,630,000	..	..	2,975,000	35,655,000
Wyoming	600,131,000	599,881,000	25,919,000	1,780,000	38,222,000	589,358,000
Miscellaneous†	307,000	307,000	259,000	..	113,000	453,000
Total United States	20,826,813,000	19,941,846,000	2,413,628,000	244,434,000	1,726,348,000	20,873,560,000

*Only a limited area is assigned to each new discovery even though the committee may believe that eventually a much larger area will produce, for in this report the concern is only with actually proved reserves.

†Includes Florida, Missouri, Tennessee, Utah, and Virginia.

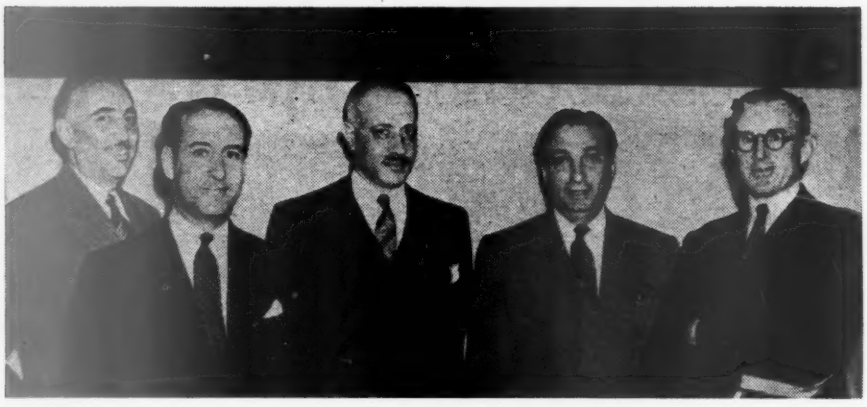
TABLE 4. Summary of committee's annual reports covering period 1937-1946

(Bbl of 42 U. S. gal.)

Year	New oil blocked out during year			Production during year	Estimated proved reserves as of end of year	Increase over previous year
	Through revisions of previous estimates and extensions to known fields	Through new pools discovered during year	Total through new discoveries, extensions and revisions			
1936	..	..	..	..	13,063,400,000	..
1937	2,792,790,000	928,742,000	3,721,532,000	1,277,664,000	15,507,268,000	2,443,868,000
1938	2,243,571,000	810,493,000	3,054,064,000	1,213,186,000	17,348,146,000	1,840,878,000
1939	2,058,455,000	340,667,000	2,399,122,000	1,264,256,000	18,483,012,000	1,134,866,000
1940	1,607,012,000	286,338,000	1,893,350,000	1,351,847,000	19,024,515,000	541,503,000
1941	1,538,989,000	429,974,000	1,968,963,000	1,404,182,000	19,589,296,000	564,781,000
1942	1,618,925,000	260,051,000	1,878,976,000	1,385,479,000	20,082,793,000	493,497,000
1943	1,202,368,000	282,418,000	1,484,786,000	1,503,427,000	20,064,152,000	(—)18,641,000
1944	1,556,192,000	511,308,000	2,067,500,000	1,678,421,000	20,453,231,000	389,079,000
1945	1,690,315,000	419,984,000	2,110,299,000	1,736,717,000	20,826,813,000	373,582,000
December 31, 1945, estimated proved reserves of crude oil only (see note below)					19,941,846,000	
1946	2,413,628,000	244,434,000	2,658,062,000	1,726,348,000	20,873,560,000	931,714,000

Note: Up to and including its figures on proved reserves of petroleum as of December 31, 1945, the committee combined under that heading the estimated proved reserves of cycle plant and lease condensate. As of December 31, 1945, the reserves so included totaled 884,967,000 bbl and as of December 31, 1944, there were 668,701,000 bbl included. Beginning with this report the figures in this table are for crude oil only. If comparison is made between new oil reported in 1946 with new oil reported in earlier years, it should be remembered that the 1946 figures for new oil do not include new condensate, which is estimated to be approximately 205,000,000 bbl.

Egyptian oil men visit United States



Left to right are N. Lanyi, formerly assistant manager for Socony-Vacuum in Cairo, and now with Magnolia Petroleum, Dallas; Mohamed Aboulezz Bey, a member of the Egyptian congress and assistant manager of Socony properties in Egypt; Hanafi El Sayed Fahmy Bey, deputy director of the Egyptian department of mines and quarries; Ibrahim Ezzat Bey, currently labor attache in the Egyptian embassy in Washington, D. C., and Duncan R. MacIntosh, representative of Shell Oil in Egypt until recently when he was transferred to Venezuela, who escorted the Egyptian party on its American tour.

A full program of visiting American oil fields and refineries and meeting American oil men was carried out by a distinguished group of Egyptian government officials who are attached to the oil industry in their work.

In the party were Hanafi Fahmy Bey, Mohamed Aboulezz Bey, Ibrahim Ezzat Bey, and their escort, Duncan R. MacIntosh. After a tour of California they went to Houston, Texas, where they were joined by N. Lanyi, formerly with Socony-Vacuum in Cairo.

During their four days in Houston the party inspected facilities of the Shell Oil Company, the Humble Oil and Refining Company, and the Magnolia Petroleum Company and conferred with officials of the three organizations.

Fahmy Bey said that Egypt in 1946 produced and refined within its borders 1,278,000 metric tons of petroleum, which was applied on the consumption of 1,873,000 metric tons. Egypt is enlarging the refining capacity at Suez from 70,000 metric tons to 150,000 metric tons annually to process royalty oil only.

"Egypt's oil policy," Fahmy Bey stated, "is not to encourage monopolies. The door is open for all companies, big and small. Our oil, when available, is to all nations on equal terms without discrimination. All we ask for is that the Egyptians have a fair share in the enterprise and the proceeds, and we do not grudge the companies their rightful share of the profits."

He explained that Egypt is producing 8,500,000 bbl of petroleum a year from four fields, two on the west side of the Gulf of Suez and two on the east side of Egyptian-Sinai. The Ras Gharig field on the west of the Gulf of Suez is a flowing and pumping field. Hurgada, farther south, is a pumping field. Abu Durba in the Sinai is a pumping field and the Ras Sudr field farther north has one well producing and one drilling. This development is known as the Anglo-Egyptian oil fields and is under Shell Oil operation.

A wildcat, four miles northwest of the Pyramids, has been drilled to 6000 ft by the Standard Oil Company of Egypt.

Ezzat Bey discussed labor conditions in the Egyptian oil industry. He said they were very simple but as the industry advanced the system would doubtless become more complicated.

Get Accurate Readings of All Tank Levels with Telematic's Guardian **LIQUID LEVEL GAUGE**

TAKE ACCURATE READINGS of all tank levels on your farm in a few minutes, each tank level showing instantly on the Telematic Indicator Panel as fast as you can turn the dial and push the button. Level appears in feet, inches and one-eighth inches in lite-up numerals (finer if desired). Fast, utterly safe, truly accurate, much less costly than hand-gauging, Telematic operates with equally high efficiency in all weather and under any atmospheric condition. Gauges any number of tanks (cone—floating roof—Horton spheroid or sphere—Graver—balloon—breather roof) connected to one Telematic Indicator Panel. Distance between tanks, or from tanks to indicator panel is not a factor. May be furnished with mechanical gauging unit at each tank or in combination with remote gauging. Also available with communications system for handset telephone plug-in at all points along the line. Write for cost-free Telematic booklet. No obligation.

TELEMATIC CORPORATION

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BAASH ROSS TOOL CO.

Baash-Ross News

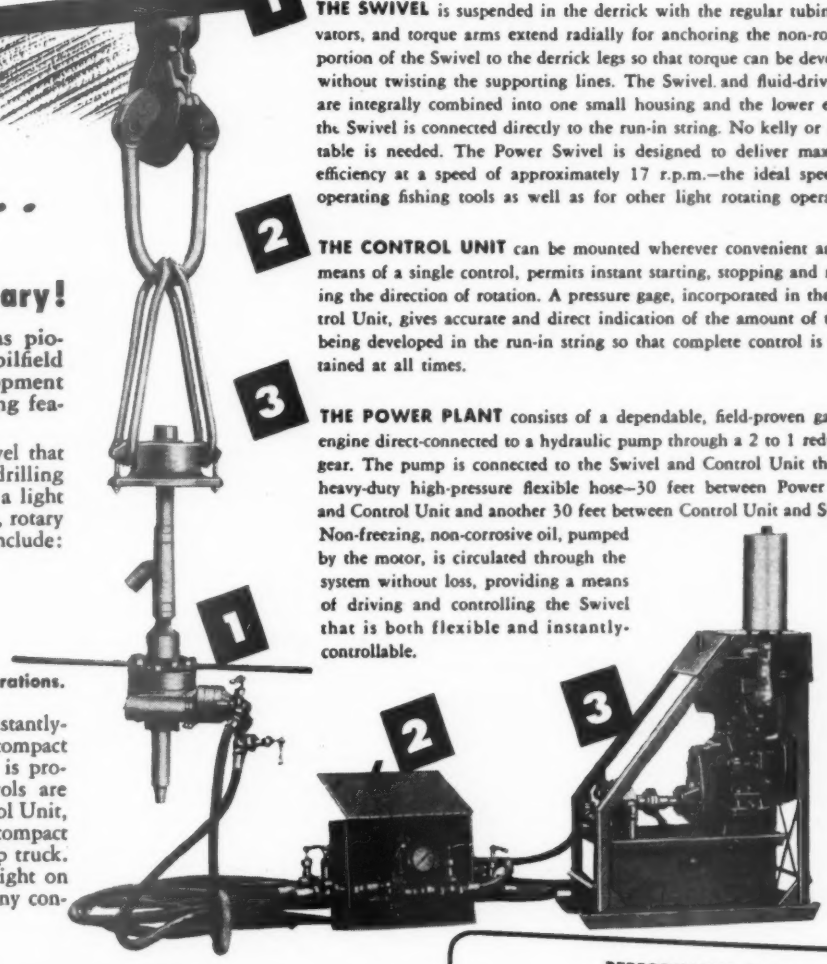
BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

OUR 27th YEAR

Again something REALLY NEW from Baash-Ross

The BAASH-ROSS POWER SWIVEL

A FLUID-DRIVE POWER UNIT that simplifies light rotating jobs!



THE SWIVEL is suspended in the derrick with the regular tubing elevators, and torque arms extend radially for anchoring the non-rotating portion of the Swivel to the derrick legs so that torque can be developed without twisting the supporting lines. The Swivel and fluid-drive unit are integrally combined into one small housing and the lower end of the Swivel is connected directly to the run-in string. No kelly or rotary table is needed. The Power Swivel is designed to deliver maximum efficiency at a speed of approximately 17 r.p.m.—the ideal speed for operating fishing tools as well as for other light rotating operations.

THE CONTROL UNIT can be mounted wherever convenient and, by means of a single control, permits instant starting, stopping and reversing the direction of rotation. A pressure gage, incorporated in the Control Unit, gives accurate and direct indication of the amount of torque being developed in the run-in string so that complete control is maintained at all times.

THE POWER PLANT consists of a dependable, field-proven gasoline engine direct-connected to a hydraulic pump through a 2 to 1 reduction gear. The pump is connected to the Swivel and Control Unit through heavy-duty high-pressure flexible hose—30 feet between Power Plant and Control Unit and another 30 feet between Control Unit and Swivel. Non-freezing, non-corrosive oil, pumped by the motor, is circulated through the system without loss, providing a means of driving and controlling the Swivel that is both flexible and instantly-controllable.

Complete...

No Rotary Table or Auxiliary Equipment Necessary!

From the same organization that has pioneered so many important advancements in oilfield equipment, comes another *really new* development that has many unique money and time-saving features. It is the Baash-Ross Power Swivel.

This unit consists of a fluid-driven Swivel that can be suspended in the rig—*any* rig, whether drilling or producing—to provide a means of rotating a light string of tools without need for installing kelly, rotary table or other heavy equipment. Applications include:

- **Internal cutting and fishing jobs**
- **Drilling out bridges**
- **Scraping liners**
- **Drilling out cement in tubing**

. . . and other similar operations.

The Swivel is driven by positive, instantly-controlled hydraulic pressure generated by a compact Power Unit, and continuous finger-tip control is provided by a Control Unit in which all controls are centralized. The entire assembly—Swivel, Control Unit, Power Plant and connecting equipment—is so compact it can be readily transported in a small pick-up truck. And if desired, the Power Plant can be left right on the truck for quick jobs—or can be set off at any convenient place on or near the rig.

PERFORMANCE DATA

Swivel	Capacity—80,000 lbs. Tensile Loading. Rotating Speed—17 RPM. Torque—12,675 inch-lbs. Elevator Neck—2⅞" O.D. Lower Stem Joint—2⅜" API Regular Pin. Goose Neck—2" API Line Pipe (female thread).
Power Unit	4 cycle gasoline engine, 9.2 h.p. at 2200 RPM, geared 2 to 1 reduction. Magneto, spark plugs and wiring all spark-proof—exhaust protected with spark arrestor. Pump equipped with safety valve for 1000 p.s.i. maximum pressure. Sump Capacity—20 U. S. gallons.
Control Unit	4-way operating valve, lever operated, fitted with lever lock. Gage—2000 p.s.i. dial type.

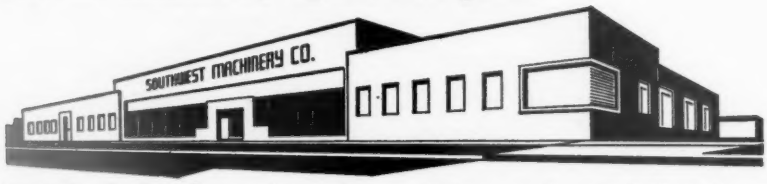
Check These Valuable Features

▸ The Baash-Ross Power Swivel offers many important advantages for rotating the run-in string on internal cutting jobs. Its uniform, sensitive hydraulic drive is far more efficient than manual rotation, eliminating irregularities and uneven feed. It is also safer because rotation can be instantly stopped and reversed to relieve any excess torque. Also, there is no need for workmen to be near the stretched pipe while it is being cut, thus safeguarding them against accidents. And, since the Power Swivel can be operated at any height in the rig there is no need for crew to work on make-shift platforms—nor is there need for cutting off the run-in string near floor level to be at convenient working height.

▸ In addition, since the Power Swivel requires no rotary table, no drawworks or other heavy equipment that is both complicated and costly to install, it is ideal for drilling out cement plugs and sand bridges, for scraping parafine and for many other light rotating jobs where sensitive control is essential and only limited torque is required.

Write for full details—or see your nearby Baash-Ross representative for additional information!

Southwest Machinery opens new plant



Forecasting its broader service to the oil industry, construction business, and public improvements, Southwest Machinery Company, pioneer distributor of Caterpillar equipment, road and construction machinery, and oil-field supplies, has opened its new home at 1900 Linwood Boulevard, Oklahoma City.

The new plant, including shop, parts department, stock room, show room, storage and offices, contains 41,030 sq ft of concrete floor space under roof and 29,330 sq ft of concrete space not roofed—more than 70,000 sq ft, or nearly two acres, of concrete floor.

Southwest Machinery Company, Oklahoma distributors for the Caterpillar and allied lines and serving the oil industry in the Southwest, was organized in 1941 to succeed the Oklahoma Tractor and Equipment Company, which had served the territory since 1927. Company officials are R. L. Hoover, president and general manager; A. L. Robertson, vice president-treasurer, in charge of sales; E. A. Butler, vice president, in charge of parts and service, and W. F. McCormick, vice president and general manager at Tulsa. Dan Griffin is manager of engine division.

The formal opening was attended by Caterpillar and other factory officials and field men, dealers, and public officials. The event included a preview of latest model Caterpillar equipment and other machinery, motion pictures, plant inspection, and outdoor demonstrations.

SPECIFY
SPANG
FOR THE BEST IN CABLE TOOLS
SPANG
"ALLIGATOR TYPE"
GRAB
The Spang "Alligator Type" Grab is especially useful for catching odd shapes and miscellaneous small parts which are generally hard to catch.
It is provided with a setting device which holds the jaws open until it has been lowered over the fish. Initial jaw tension is governed by the adjusting screw above the spring. Internal linkage increases the jaw pressure to take a very secure hold.
Fig. F525
For the best in Cable Tools,
SPECIFY SPANG
THE HIGHER STANDARD
SPANG & CO.
BUTLER, PA.
YOUR DEALER SELLS SPANG TOOLS

Tours South America

On a two months' tour of South American oil fields is Jess E. Hall, Sr., owner of the Weatherford Spring Company, manufacturers of oil well tools and specialties. Hall is accompanied by A. J. Teplitz, engineer with the Gulf Research and Development Company, and will be joined in Venezuela by Roland Smith, export director of Weatherford Spring Company.

J. E. Hall, Sr.

Hall's trip is being made at the request of some of the major oil companies, and his purpose is to acquaint producers in the South American countries with Weatherford tools and methods for the prevention of cementing failures in well completions.

Manager Chicago office

Steven T. Goode has been appointed general manager of the Chicago office of N. I. Malmstrom and Company, New York, processors of wool fat and Lanolin, used as a lubricating oil additive and in grease compounding. He joined the Chicago sales staff in 1945 after an absence of three years in the Army Air force.

S. T. Goode

Goode began his career with the company as a control chemist after which he entered the sales department, first in the New York area and later in Chicago.

Before being placed on inactive duty on June 21, 1945, he had flown 50 missions over Europe as pilot and bombardier and was decorated ten times. He attained the rank of first lieutenant while in service. Goode is a member of the Chicago Drug and Chemical Association and the Chicago Perfumery, Soap and Extract Association.

AGAINST CORROSION

Circle Ⓛ 22 and Circle Ⓛ 22XM
Lebanon's Standard "18 and 8" Alloys

THESE "18 and 8" induction furnace castings cover so broad a range of corrosion resistant requirements . . . are employed throughout industry in such a great diversity of applications that they are aptly called "workhorses of the corrosion resistant alloys".

Specific recommendations for particular needs cannot, of course, be made without careful investigation of actual service conditions. But in four cases out of five, for combating corrosion, use of Circle Ⓛ 22 or Circle Ⓛ 22-XM is indicated.

Circle Ⓛ 22 (a low carbon 18 and 8) is standard. In Circle Ⓛ 22-XM, a molybdenum variant has been added to increase resistance to many chemicals used in paper and textile industries. Circle Ⓛ 22-M contains selenium which improves the machining characteristics. Note the analyses and physical properties of each below. For additional information, send for our technical bulletin.

LEBANON STEEL FOUNDRY • LEBANON, PA.

"In The Lebanon Valley"

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

LEBANON CIRCLE Ⓛ 22

Lebanon Designation	NOMINAL ANALYSES							NOMINAL PHYSICAL PROPERTIES			
	C.	Si.	Mn.	Cr.	Ni.	Mo.	Special	Tensile Strength	Yield Point	Elongation in 2"—%	Brinell Hardness
Ⓛ22	0.07 Max.	1.25	0.75	19.50	9.00			75,000	36,000	50	135
Ⓛ22-M	0.07 Max.	1.25	0.75	19.50	9.00		Se. 0.25	80,000	40,000	45	160
Ⓛ22-XM	0.07 Max.	1.25	0.75	19.50	10.00	2.25		82,000	42,000	50	160

Lebanon CIRCLE L ALLOY AND STEEL Castings

New Sun Oil head

J. Howard Pew, president of Sun Oil Company for 35 years, announced his intention to retire from the presidency on March 18.

Pew made his announcement to Sun's board of directors. He stated he would recommend to the board of directors to be elected March 18 the election of his brother, Joseph N. Pew, Jr., now executive vice president, to a newly created post of chairman of the board of directors, and Robert G. Dunlop, now comptroller, as president of the company.

He also announced that Arthur E. Pew, Jr., had resigned as vice president in charge of manufacturing, but would continue as a member of the board.

Weco sales meeting

District representatives of Well Equipment Manufacturing Corporation, Houston, Texas, held a week's sales meeting at their Houston plant recently, the first general sales meeting since Weco was purchased several months ago by Chiksan Company, Brea, California.

J. Edgar Spear, president of Chiksan and Weco, L. J. Laird, vice president and sales manager of Chiksan, L. S. Hamer, president Hamer Oil Tool Company, W. H. Stewart, president, and T. S. Andrews, Anchor Burner Company, and Carl F. Gast, president of Carl Gast Company, were among the list of guests and visitors at the meeting.

The meeting was conducted by G. R. Winder, vice president and sales manager of Weco, and T. T. Word, Jr., assistant sales manager.

Daily meetings were held at the Weco plant. Guest luncheon speakers included E. O. Buck, southern manager of Rowan Drilling Company, A. D. Judd, vice president and general manager, Republic Supply Company, J. K. Butler, Oil Production Maintenance, and O. D. Story, division purchasing agent, Shell Oil Company.

A.P.I. meeting

The Division of Refining of the American Petroleum Institute will hold a mid-year meeting in St. Louis, Missouri, June 2 and 3, it is announced by Dr. Robert E. Wilson, API vice president for refining.

The Jefferson Hotel has been selected as headquarters for the meeting.

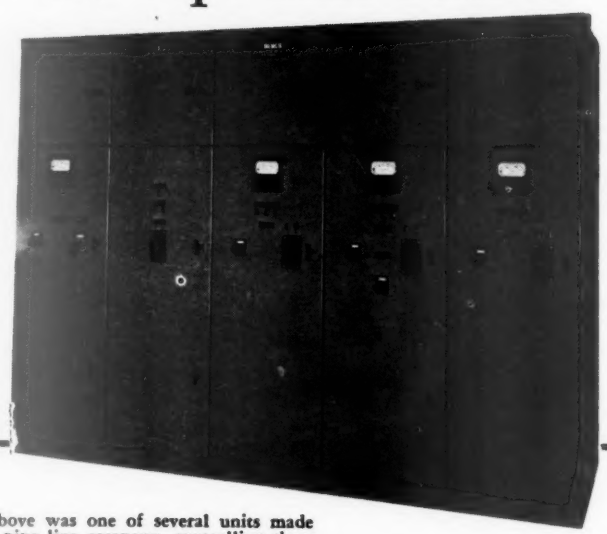
Technology will be emphasized on the program, Dr. Wilson said.

The St. Louis Convention and Publicity Bureau, 911 Locust Street, St. Louis 1, Missouri, will set up a housing bureau to handle hotel reservations.

Explosion-Proof

MOTOR CONTROL

for Pipe Line Station



The Control above was one of several units made up for a large pipe line company, controlling three 1,000 H.P. Electric Motors.

Features

- Explosion Proof, designed for installation in Class 1 Group D hazardous locations.
- Provides short circuit, single phase, overload, undervoltage, bearing temperature and oil pressure motor protection.
- Safe—Metal enclosed.
- Shipped as complete unit, reducing time of installation and field labor to a minimum.
- Quick replacement of breakers by using semi-draw-out.

Our Engineers are specialists with long experience in the design of Electrical Equipment for the Petroleum Industry and are available for consultation with your engineers in planning equipment to meet the most exacting requirements of Pipe Line Companies for both Standard and Custom-Built Electrical Equipment.

NELSON ELECTRIC MANUFACTURING CO.

217 North Detroit — TULSA, OKLAHOMA — Telephone 2-5131

MANUFACTURERS OF:

Explosion Resisting Motor Controls
Junction Boxes and Enclosures
Circuit Breakers and Lighting Panels
Oil Field Motor Controls
Automatic Pipe Line Sampling Devices
Cathodic Protection Equipment
Switchboards
Instrument and Control Panels
Unit Substations

GRADUATE

GEOLOGISTS AND GEOPHYSICISTS
For Eastern and Central Venezuela

Salaries varying from $400 to $650 a month plus living allowances.

2 WELL GEOLOGISTS—Field positions single status. 3 to 5 years' experience.
1 SEISMOGRAPH SUPERVISOR—Party chief experience. If single, field based; if married, Caracas based.
1 SEISMOLOGIST—10 years' experience. Caracas based.

Write to Atlantic Refining Co., Room 900, Box 7258, Philadelphia 1, Pennsylvania.

DRILLING SUPERINTENDENT would like to contact new oil company that is organizing a drilling department, one in need of a drilling superintendent. Desires connection with a well-financed company; however, large salary is not primary object. Prefers small salary with an interest in the company that will increase in value as company expands. Has had 30 years' experience in the drilling of oil wells in United States and South America. Address Box 65, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

PRODUCTION ENGINEER wanted by independent company operating in West and West Central Texas. Excellent prospects for young man having engineering degree and reasonable period of practical production experience. In reply please furnish summary of education and experience, age, marital status, salary desired, and date of availability. Inexpensive photo or snapshot desirable. Address P. O. Box 1727, Midland, Texas.

SITUATIONS OPEN: Chemical Engineers with three to five years' experience in the operation of petroleum refining distillation units, thermal cracking units or catalytic cracking units for work as Technical Service representatives and Operators of commercial catalytic cracking plants. Kindly send details of experience and education. Snapshot (if available). Address Box No. 59, c/o *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

new and improved machinery *and* equipment

A REGULAR FEATURE
appearing in
THE *Petroleum* **Engineer**
Irwin-Keasler Building
Dallas 1, Texas

NEW EQUIPMENT

(1) Corrosion preventives

The Tretolite Company, St. Louis 19, Missouri, announces the development of a new class of reagents for the prevention of corrosion of oil and gas well equipment. Designated as Kontol Corrosion Preventives, these inhibitors have been shown by laboratory and field testing to be effective in materially reducing corrosion in either pumping or condensate wells, it is stated.

Prior to 1942 the corrosion of condensate well equipment was virtually unrecognized, but lately it has assumed a position of major importance in the economics of condensate well operation. Recent experience indicates that with wells produced at pressure above 1500 psia and at reservoir temperatures above 160 F, corrosion may be serious if more than 0.2 per cent CO_2 by volume is present. Extensive field testing has proved Kontol 115 corrosion preventive to be especially effective in inhibiting corrosion in these wells, the manufacturer states.

Kontol 115 is a non-toxic, oil soluble, nearly odorless liquid that readily lends itself to well treatment. There is no tendency toward plugging of either the formation or well tubing by its use, for Kontol 115 does not show any reaction with salts carried by the brine, nor does it raise the pH of the brine with the possible resultant deposition of calcium or magnesium scales. Although oil soluble, Kontol 115 is surface active and builds up a thin film on the metal surface, which protects the metal from corrosive elements in either brine or condensate. As it is a concentrated inhibitor, only small volumes of Kontol 115 are required to maintain this film, and thereby effectively inhibit the corrosion of well equipment.

Kontol 115 is now being employed commercially by various producers with good results, and with no harmful effects becoming apparent after approximately a year's continuous use, the manufacturer asserts.

(2) Well-check unit

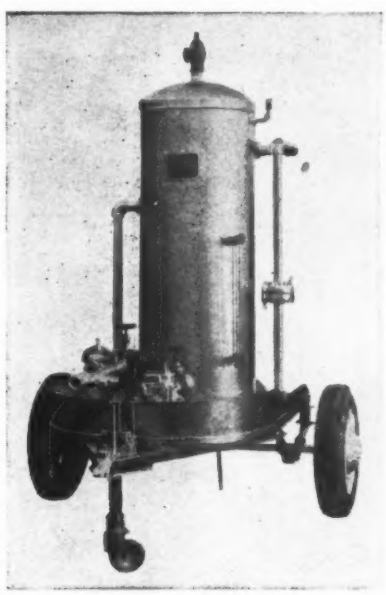
A portable outfit combining all units of the Bowser Well-Check system for oil fields has been announced by Fred C. Farmer, manager of meter sales, Bowser, Inc., Fort Wayne, Indiana. The new unit, which is marketed under the trade name "Portachek," is for use in oil fields to determine crude production quantity and quality, gas-oil ratios, and B. S. & W. of oil wells.

It is stated that this portable unit provides an accurate method for checking the potential production of new wells before permanent equipment is installed.

Production on the portable unit is well under way and prompt deliveries can be made, Farmer said.

Twenty-four hour capacities range from 175 bbl of oil and 325 M cu ft of gas at 25-lb pressure to 500 bbl of oil and 1000 M cu ft of gas at 100-lb pressure. It is said that the unit operates satisfactorily under a vacuum or at working pressures up to 125 lb.

The weights of the complete units, which are built in two sizes, are 450 lb and 1030 lb.



(3) Rubber-coated glove

United States Rubber Company has started production of a rubber-coated canvas work glove that is said to offer better protection to the hands and to have superior wearing qualities.

The glove is expected to have many industrial and household uses. The product was developed in the Providence, Rhode Island, plant of United States Rubber Company. It is made by dipping the canvas in liquid rubber up to the wrist and then vulcanizing. The result is a tough, waterproof glove that is said to outlast many pairs of ordinary canvas gloves.

(4) Larkin tubing ripper

Larkin and Company, Butler, Pennsylvania, announces the development of a new tubing ripper for oil field use. The ripper is of the drive down type, designed to run on a line with rope socket, sinkers, and jars. It is simple in design and positive in operation with only two moving parts, it is stated.

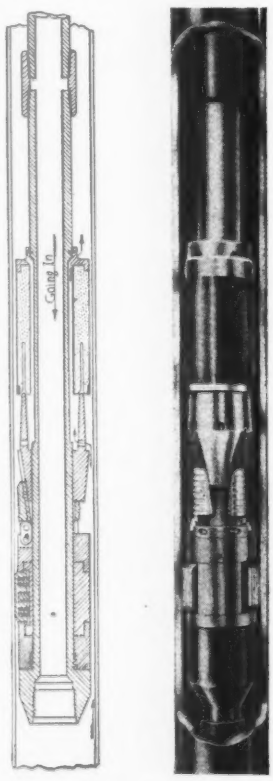
The body of the ripper is of one-piece construction, slotted on one side to take cutter bar and tension spring. A trip lock completes the assembly.

Set by hooking the trip lock over the end of the cutter bar, the ripper is run to the desired place in the tubing. Cutter bar is then unsheathed by slowly pulling up on the line. The end of the trip lock is designed to catch in the collar between the tubing joints, pulling away from the cutter bar. The tension spring then forces the cutter bar into position for ripping.

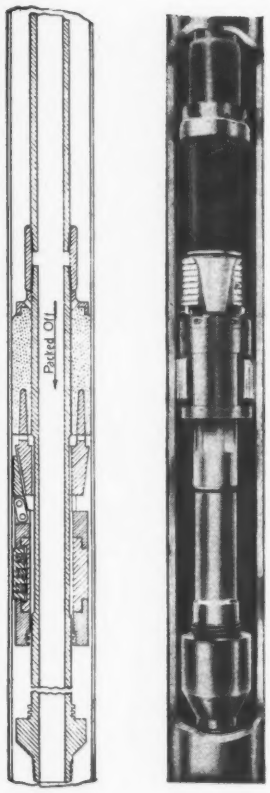
(5) Hook wall packer

In the Wilson "Positive Seal" hook wall packer, three friction blocks, hard faced with stellite are used in place of friction wiper springs. These friction blocks are held against the wall of casing by three rugged coil springs—and insure correct setting regardless of depth.

There is no "J" slot on slip retaining device. Instead, a coarse flat type thread is used to lock the slip carrier in place. To set the Wilson "Positive Seal" packer, tubing must be turned 2½ revolutions—a feature that eliminates accidental setting and resultant damage to packer.



Going in hole



Set

The non-vulcanizing pack-off element is expanded by conical wedge—and does not depend on excessive tubing weight on the packer to effect pack-off. The split pack-off gives a "lip-seal," which means that the higher the pressure from below the tighter the seal.

Wilson Foundry and Machine Company, Houston, Texas, is the manufacturer.

(6) Dynalog controller

Among the features added since the war to the Foxboro line of instruments for measurement and control is the new Dynalog electronic recording pyrometer. This instrument has attracted much attention because of its many revolutionary improvements, says the manufacturer, The Foxboro Company, Foxboro, Massachusetts. It has no galvanometer, no slide wire, no dry cell, and requires no standardizing. Because of the instrument's continuous balancing action, the recording pen can traverse the full width of the chart in one second's time. Sensitivity is 1/10 of 1 per cent of the full scale range. For applications of temperature measurement, Dynalog instruments are available with ranges between minus 200 F and plus 2800 F, and for use with thermocouples or electric resistance bulbs. Recorders and recording controllers are offered. A giant indicating scale, for long-distance reading, is an optional additional feature.

A special reason for interest in the Dynalog all-electronic instruments is their unusual versatility. In addition to temperature applications, they are also in use for the measurement or control of humidity, force, strain, pH, speed, and many other process variables.

(7) Stainless steel electrodes

A complete line of stainless steel electrodes in a full range of grades and diameters has been announced by Air Reduction Sales Company, 60 East 42nd Street, New York 17, New York.

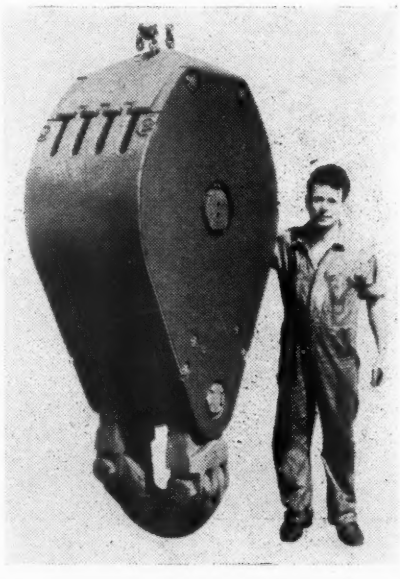
All Airco stainless steel electrodes are supplied with a heavy extruded lime type coating for d-c application. In addition all but the straight chrome analyses are obtainable with a lime-titania type coating that is usable on alternating current or direct current. The slag produced by either of these coatings is easily removed.

Electrodes with the lime-titania (a.c.-d-c.) type coating offer many features, it is stated. For example, satisfactory usability on alternating current eliminates arc blow and results in easy manipulation, uniform arc action, and good appearance of deposit, the manufacturer states.

(8) McKissick block

The new McKissick block, shown in the accompanying illustration, is designed as a 60 in. traveling block but actually stands much higher. Streamlined to assure accurate balance for straight fall and added safety, it is compactly engineered and allows maximum derrick working space.

The large diameter center pin guarantees strength and longer bearing life. The alloy steel sheaves with API standard grooves are heat treated for maximum wear. This new block is equipped with Hy-load roller bearings with Alemite lubrication. It has 200-ton capacity with ample safety factor. The block can be provided with an adapter, which may be connected to drilling hook with a short, rigid coupling.



SCHLUMBERGER

Integrated WELL SERVICE

SAVES COSTLY RIG TIME!

On a single trip to the well, the Schlumberger field unit can be equipped to make all of these surveys, each being run on the same standard Schlumberger cable. The use of a quick-change connector between the cable and the various Schlumberger sub-surface instruments requires only one set-up operation for the several different surveys.

Considering the high cost of rig time, many operators recognize the sound economy afforded by Schlumberger Integrated Well Service.

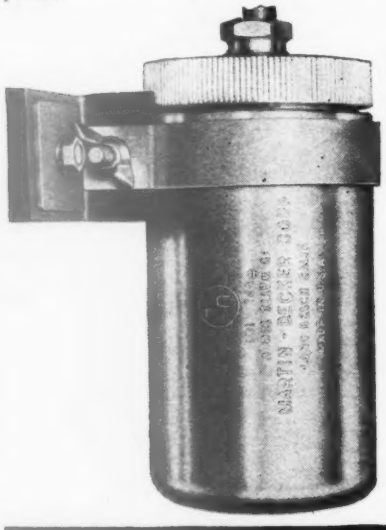
Call Schlumberger For Your Next Gun Perforation

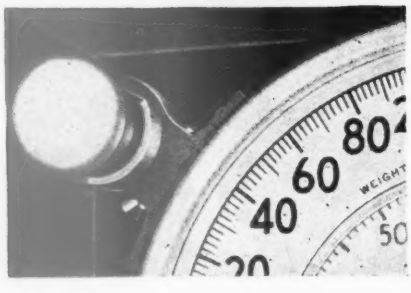
SCHLUMBERGER WELL SURVEYING CORPORATION • HOUSTON • TEXAS

(9) Panel light fixture

Martin-Decker Corporation, Long Beach, California, has placed on the market an adjustable vapor-proof and moisture proof lamp for use on drilling control instruments. Extremely rugged and easily adjusted the fixture provides maximum oilfield usefulness and service, it is stated. It has been tested by the Underwriters' Laboratory and bears their seal of approval.

Made of die cast aluminum with pyrex glass tubing and 15-watt lamp set in a cork gasket, it comes equipped with 20 ft of approved 3-cable cord and cord cap. (The male plug is not vapor-proof.) The lamp is extremely compact, being only 5½ in. long and 2¾ in. in diam. A flexible rubber bracket is provided for mounting the fixture on a gauge ring or panel.





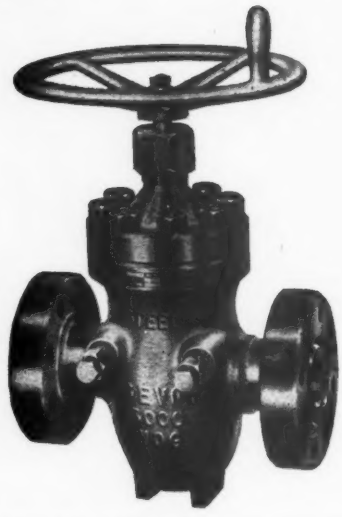
(10) Oil field valve

A new conduit gate valve, especially designed for high pressure oil field service, has been announced by the McEvoy Company, Houston, Texas.

Features include an automatic lubrication system that continuously protects the valve from leaks. The system is arranged so lubricant is automatically injected from a reservoir to the sealing area whenever it is needed.

Other features include non-distorting seats, gate halves that automatically align themselves to the undistorted seats, and hard chrome plated sealing surfaces.

The manufacturer reports that early models have been used successfully on condensate wells and high temperature, very corrosive wells. In view of this service, the manufacturer has decided



to offer the valve with a one year guarantee. This guarantee offers free repair of any valve that needs service within one year of the time it is shipped from the plant.

The McEvoy valve is offered in four sizes: 2 in., 2½ in., 3 in., and 4 in., and in 5000 lb, 3000 lb, and 2000 lb W. O. G. working pressures. It is available in either the standard model with chrome plated stem and sealing surfaces or the all stainless model for severe corrosive conditions.

(11) Swivel joint

The Roofe Machine Works, Inc., Houston, Texas, has developed a new high pressure swivel joint for use in the oil industry. This joint was developed to meet the ever-increasing pressures enountered in deep well drilling, cementing, acidizing, and plastic work. The Roofe swivel joint has a working pressure of 10,000 psi with a test of 20,000 psi and still maintains adequate safety factors, according to the manufacturer.

Simplicity of design is a feature of this joint as there are no locking rings or bolts and no adjustments to be made. No special tools are needed for the replacement of parts.

The Roofe swivel joint will swivel by hand at 50 per cent of the working pressure and rotates 360 deg. High temperature, high pressure Chevron packing, especially designed for the Roofe swivel joint, is used throughout.

Roller bearings are flat with the outer surface slightly oval for clearances in the roller races.

A special designed packing chamber permits the lubricants to lift the lips of the packing the instant the pressure is applied. This feature prevents, to a minimum, the possibility of leakage at any point.

A gasket between the male and female members, at the extreme inside end of the male member, serves to resist abrasion caused by the turbulence of fluid, drilling mud or cement, passing through the joint at this point.

Joints are being manufactured in sizes 1 in. to 4 in. inclusive, with a choice of style to meet requirements.

The Roofe medium pressure swivel joint has all the basic features of the high pressure joint and is rated 0 to 4000 psi working pressure with a test of 8000 psi.

(12) Serrated fin tubing

Cal-Fin Company is now manufacturing in South Pasadena, California, under license from Extended Surface Division, David E. Kennedy, Inc., a type of serrated fin tubing that is particularly suitable for use in fan-cooled sections as applied to the cooling of jacket water, high pressure gas, exhaust steam, etc.

For oil field service, standard material is admiralty tubing with copper fins. Stock tubing sizes are ⅝ in. and 1 in. OD 18-gauge. Stock lengths are 16 ft and 20 ft. Stock fin heights are 7/16 in and 9/16 in. Fin pitch can be supplied as desired up to 8 fins per in. The tubing comes accurately cut to length with ends stripped, polished, and reamed.

Serrated fin design gives unusually high transfer rates on air side in relation to air pressure drop, it is asserted.

(13) Biggest shovel dipper

The world's largest shovel dipper has been completed by Marion Power Shovel Company of Marion, Ohio, and placed in operation on a Marion Type 5561 shovel.

This giant dipper is capable of moving enough earth at one bite to fill a room 12 ft long, 10 ft wide, and 9 ft high. On the 5561, this dipper can move the giant load two-thirds of a city block and drop it on top of a seven-story building.

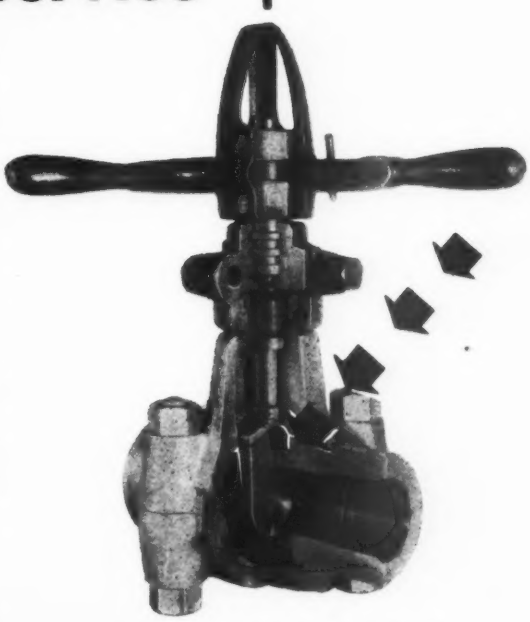
Construction of the 40-yd dipper and a newly designed handle for it were made possible by the application of war-developed steels of new tensile strength and resistance to abrasion. These new steels cleared the way for a dipper and handle design that is 30,000 lb lighter than materials formerly used in achieving the same strength. Thus, it was possible to install the 40-yd dipper on a machine that has been handling a 35 cu yd dipper in the past without adding to the front-end weight of the ma-

CAMERON "FLEX-SEAL" Mud Line Valves

The one and only valve designed expressly for mud line service

There's just one mud line valve . . . Cameron "Flex-Seal". Unlike ordinary all-purpose valves and stop cocks, this valve was designed expressly to withstand the abrasive action of drilling fluid moving at high velocity. No metal valve seats should be expected to withstand, for any appreciable time, such destructive force. But "Flex-Seals" employ a resilient flow-way insert which slowly absorbs the abrasive action of drilling fluid. When finally worn out, the insert may be replaced at the rig by any member of the crew. This renewable insert also provides a pressure-tight seat for the gate and seals the two-piece valve body.

Hubs of the "Flex-Seal" valves are attached to the body by means of interlocking shoulders and grooves which permit the valve to swivel when making up in a manifold. This design permits changing from screwed to flanged, weld-on or any type connection desired in the field. These are some of the reasons why "Flex-Seal" valves have been universally accepted as *the* mud line valve. Complete details will gladly be sent on request.

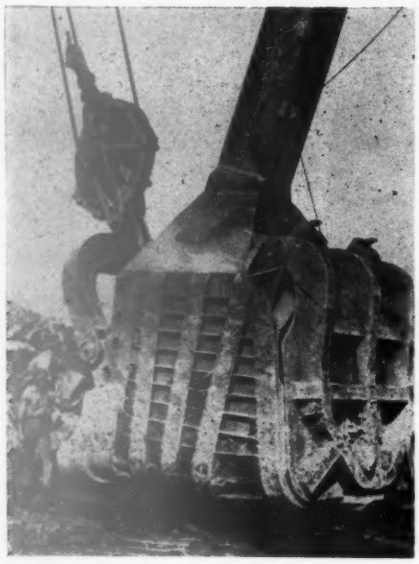


A Cameron "Flex-Seal" in closed position. Note how the gate seats in the resilient flow-way insert (red).

CAMERON IRON WORKS, INC.

P. O. BOX 1212, HOUSTON, TEXAS

Export: 74 Trinity Place, New York, N. Y. West Texas: Odessa, Telephone 1710. Oklahoma: 310 Thompson Bldg., Tulsa. California: 1442 Hayes Ave., Long Beach. Wyoming: 356 N. Wolcott St., Casper. North Louisiana: Bossier City (P. O. Box 425).



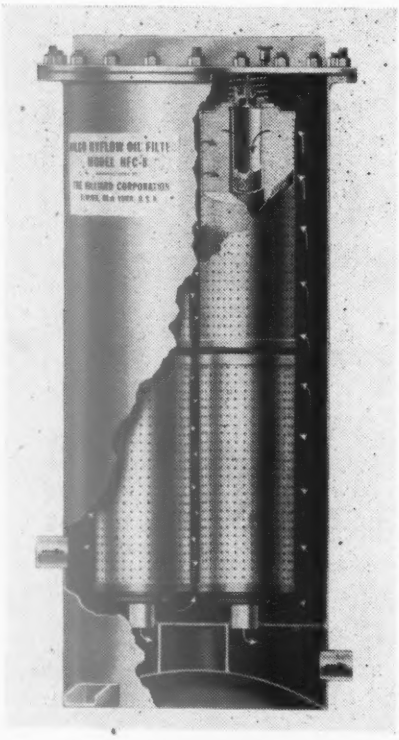
chine, even when the big dipper is fully loaded.

The Marion machine is powered entirely by electricity, and its power consumption is equal to that of a community of 3000 persons.

(14) Oil filters

The Hilliard Corporation, Elmira, New York, is announcing a new line of lubricating, fuel, and industrial oil filters. These units are constructed of steel and utilize from 1 to 18 filter cartridges, measuring 7¼ in. by 18 in.

These Hilco Hyflow oil filter units are available with or without heaters. The oil is delivered to the inlet of the filter and is forced from the outside of the filter cartridge toward the center and then out through the outlet back to the system, either by means of an auxiliary motor-driven pump set or directly from engine or equipment pressure. Hilco units may be operated as bypass or full-flow filters, depending on the flow rate required.



(15) Welding fittings

Ladish Company, Cudahy, Wisconsin, producers of Ladish forged steel fittings and forged steel flanges, has introduced a new line of controlled quality seamless welding pipe fittings.

Already being stocked by authorized Ladish distributors in principal centers, the new line consists of 90 deg and 45 deg elbows, 180 deg return bends, straight and reducing tees, concentric and eccentric reducers, caps, lap joint stub ends, saddles, shaped nipples, crosses, and tees in carbon steel, sizes up to 30 in.

Features inherent to the complete line of Ladish seamless welding fittings include uniform wall thickness, accurate circularity, full effective radii, smooth inner walls, machined bevel-ends, and improved metal structure.

Although designed and manufactured in accordance with recommendations of the American Standards Association and other standards, Ladish seamless welding fittings have many distinctive features, it is stated, chief among which is a new tapered tee design. Achieved through scientific metal distribution, the center sections and the crotch are reinforced, the metal tapering off to nominal pipe size at the ends. This new application of the taper principal has resulted in a tee that provides great strength and durability under severe operating conditions, it is stated.

In addition to the new tapered design, Ladish tees have a long inner crotch radius that reduces friction and turbulence, thus minimizing pressure loss. Full length branch outlets facilitate the welding operation.

(16) Engine controls

Synchro-Start automatic engine controls, virtually unobtainable during the war, are now available in quantity to all manufacturers, distributors, dealers, and users of gas, gasoline, and diesel engines, it is announced by Synchro-Start Products, Inc., Chicago, Illinois.

The standard controls line includes: Full automatic starting, stopping and protecting systems, over-speed governors, solenoids, automatic cranking units, safety stop controls with indicating signals, heavy duty starting motor contactors, relays, and multiple engine panel boards.

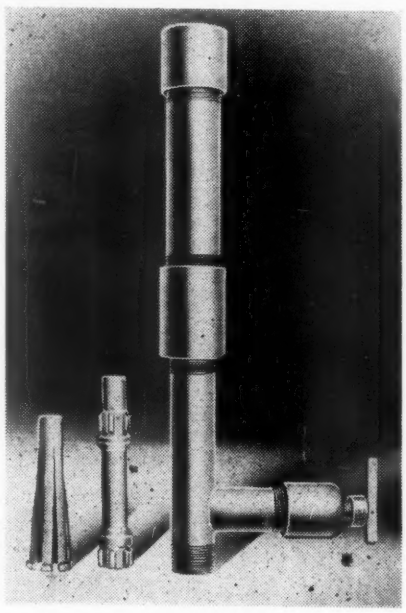
The new automotive lines include automatic starting and transmission controls for trucks, busses, motor cars, and power boats. Electronic controls, developed during the war, are offered this year to the general industrial market on a "custom-built" basis.

Many interesting new Synchro-Start applications have been developed during the last few years. Of especial interest are automatic engine-driven fire pumps, an automatic pump system for clearing flooded underpasses, and multiple engine-generator installations that automatically start and stop additional engines according to load demand.

(17) Paraffin Knife

The Merla Tool Corporation, Dallas, Texas, announces the design and manufacture of a new type automatic paraffin knife.

The Merla automatic paraffin knife is designed for use in natural flowing wells or wells operated by gas lift equipment; it operates on the energy of the tubing flow. The automatic operation of this knife eliminates the necessity of periodically moving wire line paraffin cutting equipment to a well to cut the paraffin and keep the tubing open. This knife does it's work in conjunction with the producing of the well.



(18) Elevator links

Web Wilson Oil Tools, Huntington Park, California, announces new elevator links that are said to provide the maximum in drilling efficiency and economy. Designed for maximum strength and longer life, the new Web Wilson links are available with bent or straight upper and lower eyes. Wire line handles are optional.

The new Web Wilson elevator links incorporate the finest in high-hardenability alloy steel, are heat-treated to rigid requirements in modern vertical furnaces, checked 100 per cent for hardness and dimensional requirements, and magnafluxed to assure highest quality, it is asserted.

A TIP ON HOW TO INCREASE DRILL PIPE LIFE

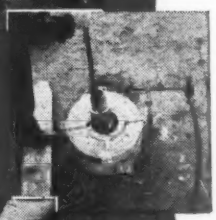
Stuck Pipe should never be pulled beyond its yield point, except as a last desperate measure. But before the yield is even approached, all known methods for freeing stuck pipe should be tried.

It's easy to replace Spang Shrink Thread Tool Joints right at the rig. All you have to do is torch notch the worn joint, remove old joint, drive in a wedge, heat a new joint and put it on by hand.

HERE'S THE WAY

to eliminate . . last engaged thread failure

. . . USE SPANG SHRINK THREAD DRILL PIPE AND TOOL JOINTS



1. Torch Notch The Worn Joint And Remove By Hand

2. Heat New Joint to 650° to 700°F in Portable Heater

3. Apply New Joint By Hand

On Spang Shrink Thread Drill Pipe, the root diameter of the pipe thread at the runout is equal to or greater than the outside diameter of the pipe. Every pipe thread is engaged and its root is supported by a crest of a tool joint thread. The notch effect at the bottom of the conventional "Vee type" threads is eliminated.

Spang Shrink Thread Drill Pipe and Tool Joints save you time and money in other ways, too. They prevent leakage and washout through drill pipe threads. And the Tool Joints can be changed at the rig with a portable furnace and a few hand tools.

Insist on Spang Shrink Thread Drill Pipe and Tool Joints for your strings. That's the only way you can be sure of getting every one of these money-saving advantages.

***SPANG TUBULAR GOODS*—Spang-Chalfant tubular goods have earned a world-wide reputation for unexcelled quality. This pipe is made to meet every oil field need.**

SPANG-CHALFANT

Division of The National Supply Co. • Executive Office: Pittsburgh, Pa.

District Sales Offices: ATLANTA; BOSTON; CHICAGO; DENVER; DETROIT; HOUSTON; LOS ANGELES; NEW YORK; PHILADELPHIA; PITTSBURGH; ST. LOUIS; SAN FRANCISCO; TULSA

(19) LPG vaporizer

An improved vaporizer for use in industrial LP-Gas systems is announced by the John E. Mitchell Company, Dallas, Texas.

The new Mitchell is a unit by itself apart from the supply tank, and operates by using heat in a closed chamber to vaporize gas. It can be operated either with above ground or below ground tanks. As the Mitchell draws out chiefly liquid fuel, the tank does not lose pressure or frost up due to heavy withdrawals; also the vaporizer does not draw off the propane first in a butane-propane mixture. Thus two principal causes of "dead tanks" are eliminated. Gas is dry and requires but one burner adjustment in a tankful. After this adjustment, according to Mitchell engineers, the flame remains bright blue, and of uniform heat value, thereby minimizing sooty deposits and insuring heat output of high efficiency.

Operation of the Mitchell vaporizer depends on a new principle known as automatic selective control. This works to relieve unusually heavy demand upon the vaporizer by withdrawing tank gas as needed. Hence, it is asserted, excessive pressure cannot build up in the vaporizer or tank, and no liquid can enter the vapor line—factors of utmost importance to safe operation.

For nearly every application where the load is radial you'll find an AMERICAN RADIAL ROLLER BEARING to meet your requirements. Engineered to exacting standards, precision tested, specially designed for smooth, reliable operation under tremendous loads, AMERICAN RADIAL ROLLER BEARINGS function flawlessly in the heaviest equipment built and under the most rigorous operating conditions encountered in any industry.

AMERICAN RADIAL ROLLER BEARINGS come in 5 styles, 4 S.A.E. series and 85 sizes. Special designs to order are also available. Our engineers will cooperate with your own technical staff on all your roller bearing problems.

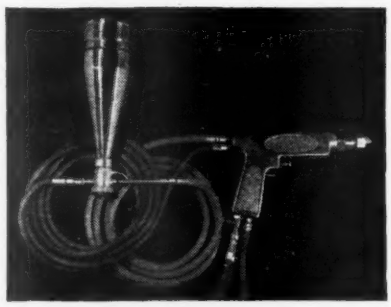
AMERICAN ROLLER BEARING CO.
PITTSBURGH, PENNSYLVANIA
Pacific Coast Office:
1718 S. Flower St., Los Angeles, California

AMERICAN
Heavy-Duty ROLLER BEARINGS

(20) Spraywelder

A new type of powder metallizing unit, the Colmonoy Spraywelder, has been announced by Wall Colmonoy Corporation, Detroit, Michigan.

The spraywelder was developed for use in conjunction with the Colomony Sprayweld Process. With this new unit it is possible to combine the advantages of both welding and metallizing procedure, it is asserted. The unit is operated in the first part of the process as a powder metallizing unit to apply a uniform overlay of the Colmonoy hard-facing alloy. It is then used as a conventional welding torch to fuse this sprayed overlay to the base metal to obtain a fusion or molecular bond, identical to that obtained when the same alloy in rod form is applied by acetylene welding.



The unit has only two control valves, both being mounted on the gun itself. Once adjusted, the powder flow may be stopped and started at will by pressing or releasing the trigger. The gun is light in weight and perfectly balanced. It may be hand operated, or held in a vise or with an attachment in the tool post of a lathe. Because of its design, it may be easily operated in all positions.

(21) Differentials

Detroit Automotive Products Corporation is now in production and is supplying its distributors with 28 models of its NoSPIN differential in four basic sizes, series "C," "G," "J," and the new "E" according to Ivan Graham, manager of sales and service of this firm, which was formerly the Thornton Tandem Company.

Detroit Automotive is making available at this time the new series "E" NoSPIN differentials for two-speed axles of the Eaton 1350 series. These differentials can now be installed in the two-speed axles of such popular trucks as the Ford 2-ton, Dodge WFA and WHA, Fargo FKA4 and FKA6, International KS5 and KS6, Federal 15K and 18K, GMC models EC and EF, series 300 and 350, Diamond T models 404, 409, 409SC, R-950, and Canadian Chevrolet Maple Leaf.

Latest additional models being released include the series "J" NoSPIN differentials for several popular truck models including: Dodge WF and WH, and Fargo FK4, and FK6 trucks all equipped with single speed axles, and

Chevrolet 2-ton trucks having two-speed axles.

When the NoSPIN differential is used to replace the conventional differential in truck axles, it assures positive drive to both rear wheels yet provides differential action automatically when required, the manufacturer states. Thus greater traction is obtained.

Detroit Automotive NoSPIN differentials are distributed in the U. S. by Truckstell Distributors and in export markets by Herthornway Export Corporation.

(22) Emsco swivels

The manufacture of a new series of oil field swivels has been announced by Emsco Derrick and Equipment Company, Los Angeles, California. These new swivels, known as the Emsco JV Series, incorporate all Emsco design features, plus numerous new and exclusive improvements, states manufacturer.

Designed for medium and deep drilling, the new Emsco JV Swivels are available in types JV-7, JV-9, and JV-12.

Several totally new and unusual design features have been incorporated in the new Emsco JV series of swivels, it is announced. Outstanding among these are: A two-piece, demountable, steel bail; simplified hose connection permitting packing replacement without disconnecting hose; venturi-type wash pipe and sleeve; cartridge-style wash pipe packing, and maximum vertical spacing at radial roller bearing that maintains positive alignment of sleeve and packing assembly with wash pipe.

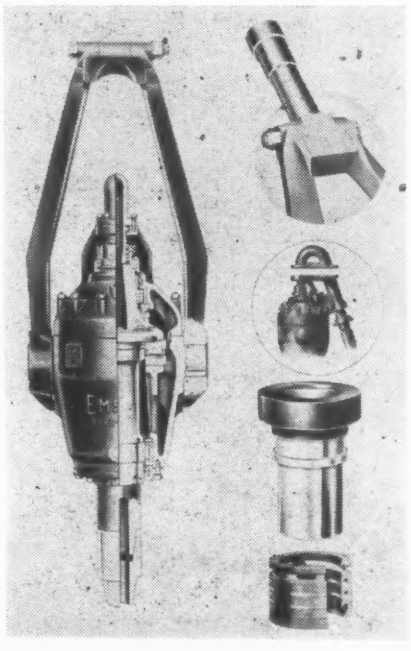
All JV swivels have the new Emsco demountable steel bail. This bail can be readily converted from the conventional or hook type to that using the elevator shank as is clearly shown in the accompanying illustration.

The tapered design of the bail arms distributes load stresses equally. Easy removal of bail arms permits field repair and assembly. Due to precision design, close trunnion fitting is possible eliminating excessive wear between trunnions and bail.

The new style gooseneck is so designed that its removal does not necessitate uncoupling of the mud hose. (See illustration.) This gooseneck design permits easy replacement of wash pipe packing without disconnecting hose.

The fluid channel through wash pipe and sleeve assembly (see cut-away illustration of swivel) is designed to afford a venturi type passageway. This considerably increases life of wash pipe packing by inducing a high velocity, low pressure area adjacent to packing.

A special factory assembled cartridge-style packing has been developed for use with Emsco JV Series swivels.



(23) Light hand-lift truck

As a useful handy-man for handling "short move" jobs involving loads up to a ton, Arcade Manufacturing Division, Rockwell Manufacturing Company announces a new light hand-lift truck. This husky, durable truck has proved popular in plants for moving skid-loads, boxes and trays of material, and countless miscellaneous items, it is stated. Overall length of the truck is 70 in. and the platform area is 11¾ by 43 in.

POWER WHEEL

It is now lighter, stronger and more efficient. Slightest pressure of fluid puts the Thompson machine in operation.

EFFICIENTLY HANDLES THE FLOW OF MUD FROM LARGEST PUMPS NOW IN OPERATION

The new Thompson "DW" Model is the ideal mud conditioner for your larger operations. Its capacity has been increased to the extent that it will handle the mud and pressure from the largest mud pumps now in operation. The Power Wheel has been redesigned and increased in size for greater efficiency.

This new model is Self-Motivated, a feature pioneered by Thompson—operates entirely from the flow of mud. The Sample Machine is standard equipment, unless otherwise specified . . . its the field-tested method of providing accurate samples of foot by foot cuttings.

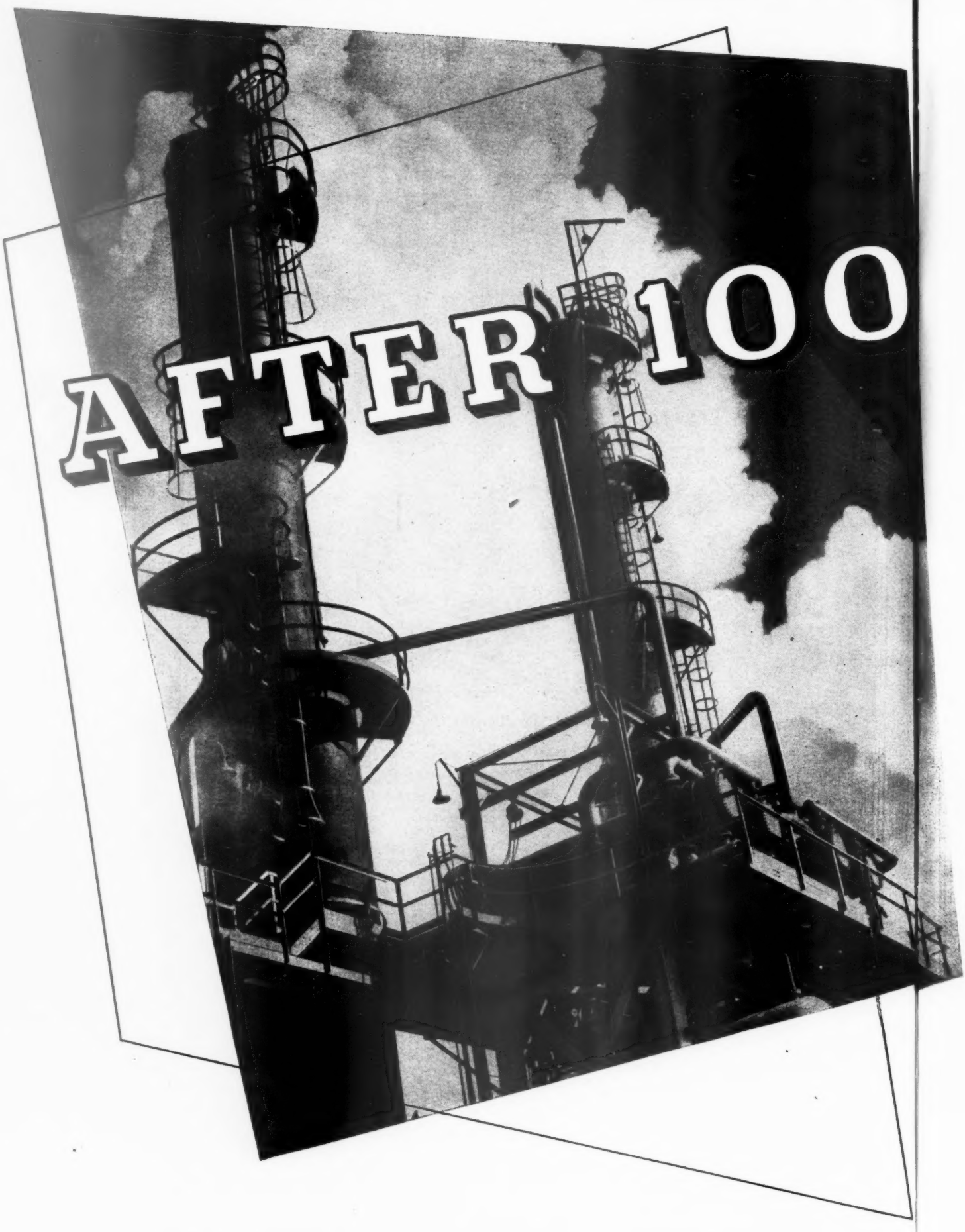
Your order can be filled promptly, so place it now!

- SELF-MOTIVATED
- RECONDITIONS MUD
- ACCURATE SAMPLES
- UNLIMITED CAPACITY

THOMPSON TOOL CO.

IOWA PARK, TEXAS

KEEPS DRILLING MUD CLEAN — PROVIDES TRUE SAMPLES OF CUTTINGS


AFTER 100

OCTANE, What?

Between 1941 and 1945 the American Petroleum Industry performed one of the greatest industrial miracles of all time. As the world knows, it was the quantity production of 100-octane gasoline. Production rocketed from a bare 40,000 barrels daily in 1941 to over 500,000 barrels daily. Even the rating 100-octane was left behind.

Today the world is waiting for other miracles from petroleum, products that will serve a world of peace. Many are already in the making in research laboratories. And in the new processes American meters will play a dependable part as they do in so many producing and refining processes today. American Meter research, backed by 109 years of meter experience, stands ready to meet the exacting requirements of the petroleum and chemical industries for the measurement, control and analysis of gases and liquids.

AMONG THE MANY AMERICAN METER COMPANY PRODUCTS FOR APPLICATION IN THE PETROLEUM AND CHEMICAL INDUSTRY ARE

ORIFICE METER AND FLOWMETERS—Indicating, Recording and Integrating types.

RECORDERS AND CONTROLLERS—With pneumatic transmission. Developed for the improved transmission, recording and control of pressures, liquid levels and flow rates.

AMERICAN METER COMPANY

trade literature

PUBLICATIONS LISTED ARE SENT FREE UPON REQUEST

(24) Protective equipment

Viking Instruments, Inc., East Haddam, Connecticut, has issued a revised catalog that covers protective equipment for internal-combustion engines.

(25) Heavy duty trucks

The Four Wheel Drive Auto Company, Clintonville, Wisconsin, has published the new FWD "M" series folder. (Bulletin No. 461). This illustrated bulletin describes 10 and 12-ton FWD trucks, built for heavy duty service.

(26) Drill pipe, casing, tubing

Seamless drill pipe, casing, and tubing are illustrated and discussed in detail in a new bulletin issued by National Tube Company, Pittsburgh, Pennsylvania. Seamless pipe construction, types of joints, weights and dimensions, and setting depths —all are treated. Much engineering data are included, such as those on determining resistance to collapse in mud of various densities, on determining performance properties of API casing, on designing a 11,000-ft casing combination string, etc.

(27) Kaskade fractionating tray

The Koch Engineering Company, Inc., Wichita, Kansas, has issued a booklet showing a new type fractionating tray for refineries. Known as the Koch Kaskade Tray, the manufacturer asserts that it gives higher liquid and vapor capacities, less entrainment, lower pressure drops, and higher efficiencies.

(28) "Oilwell" equipment

Oil Well Supply Company, Dallas, Texas, has issued a number of bulletins describing its drilling and production machinery. Included are bulletins on various types of rotary drilling units, pumping units, slush pumps, power pumps, crown blocks.

(29) Ideal swivel

A new bulletin describing The National Supply Company's Ideal Type R-3 Swivel for rotary drilling rigs includes a life expectancy chart for the main bearing. This chart is based on a rating of 200 tons at 150 rpm. The 8-page bulletin carries nine explosion photographs, a blueprint, complete specifications, and a detailed description of its construction. A patented feature of the swivel is the wash pipe packing assembly that insures a positive pressure packed seal that can be removed by one man without disturbing the gooseneck or hose connection.

(30) Submersible pump

The Pump Division of Byron Jackson Company, Los Angeles, has released a new 12-page bulletin (No. 46-5000) on its deep-well turbine pump and electric motor unit known as the "Submersible Pump," a motor pump unit that operates entirely submerged in water at any depth, for pumping applications requiring capacities of 7000 gpm to 20,000 gpm and heads to 1500 ft. Printed and illustrated in three colors with photographs, parts diagrams and tabular data, the bulletin covers specifically three different types of submersible pumps.

(31) Flowrator dimensions

For the first time F&P has combined into a single bulletin a complete set of certified dimensions covering every available combination of the Series 700 Flowrater instrument (Rotameter). This book is devoid of all sales information in an effort to reduce to the handiest possible form, comprehensive and accurate dimensional information so important to the piping layout draftsman. Various types of indicating Flowrator instruments, along with panel mounting arrangements, alarm attachments, electrical transmitters, pneumatic transmitters, and recorder-controller accessories are included in this engineering composite, made by Fischer and Porter Company, Hatboro, Pa.

(32) Dust problems

A new 23-page illustrated booklet compiled by American Air Filter Company, Inc., discusses various types of industrial dust problems and typical applications of AAF air filters to such problems. Included in this highly enlightening booklet are a chart of size and characteristics of air-borne solids and sections dealing with atmospheric dust, and filtered air.

(33) How to stop fires

As a public service, and in the interest of reducing the enormous fire losses, the American-LaFrance-Foamite Corporation of Elmira, New York, has published a 24-page illustrated book entitled "What You Should Know About Modern Fire-Fighting Devices," and offers it free of charge. The book is of educational nature and not only describes, but illustrates the proper use of the various types of fire-fighting devices for the class of fire for which each is intended.

(34) McEvoy valve catalog

The McEvoy Company, Houston, Texas, is offering a 20-page catalog describing its new automatic lubrication conduit gate valve for oil-field service. The catalog includes vividly illustrated descriptions of the principal features of the new valve. These illustrations use three colors to increase the clarity of the explanations. Complete specifications, a concise report on the performance of the valves, and a full color cutaway drawing are also included.

(35) New tractor catalog

Selection of the right tractor for your job is simplified by a new catalog of International wheel tractors that is now available. This illustrated, 24-page, 2-color catalog lists many of the applications for which International industrial tractors are used and illustrates some of the matched equipment available with them. Three models of heavy-duty tractors powered by gasoline engines, which can be equipped to burn kerosine or distillate, are completely described and illustrated. All specifications are given. Two models of diesel-powered heavy-duty tractors are similarly described and illustrated with all specifications given. A light tractor powered by a gasoline engine for highway mowing and similar applications is also illustrated and described. Inernational Harvester Company, Chicago, Illinois, is the manufacturer.

(36) Transmission belting

Specifications and construction features of Monarch brand transmission belting are outlined by Hewitt Rubber division of Hewitt-Robins, Inc., in a 4-page product folder now being distributed. Monarch is said to withstand the shock loads of the heaviest service. All plies are straight-laid under uniform tension, assuring greater freedom from stretch and increased power delivery. Absence of folds and seams makes it possible to apply either side of the belt to the pulley.

(37) Ric-wil conduit systems

Ric-wil prefabricated conduit systems for underground and overhead steam, oil, or hot water lines are discussed and illustrated in Catalog No. 44, issued by The Ric-wil Company, Cleveland, Ohio. The Type UL system is particularly adaptable for refineries and synthetic rubber plants. This type has pipes insulated from the exterior, but not from one another, accomplished by providing a molded liner insulation inside the conduit shell. This system is used for piping oil or viscous fluids when a steam tracer line parallels the transmission line, to maintain a constant temperature.

(38) Caustic soda book

An elaborate 72-page text has been published by the Pittsburgh Plate Glass Company, Columbia Chemical Division, designed for use by technical men, buyers, and executives interested in the economics of caustic soda; the operations man who is interested in the best procedures for unloading, handling, and storing this chemical; the engineer who must design equipment, and the student or layman who desires useful data on the characteristics, uses, forms, transportation, constants, etc., of caustic soda. The book is printed in three colors throughout and contains many useful graphs, charts, and diagrams as well as being profusely illustrated with descriptive photographs.

the Petroleum Engineer's CONTINUOUS TABLES

a daily reference for operating mer

INSTALLMENT No. 117

A valuab'e and regular feature of *The Petroleum Engineer*, the Continuous Tables, now in their tenth year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*. Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have been developed as a result of suggestions for new tables, direct contributions and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive, in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue; 104-106, inclusive, in the April, 1946, issue; 107-109, inclusive, in the July, 1946, issue; 110-112, inclusive, in the October, 1946, issue; 113-115, inclusive, in the January, 1947, issue.

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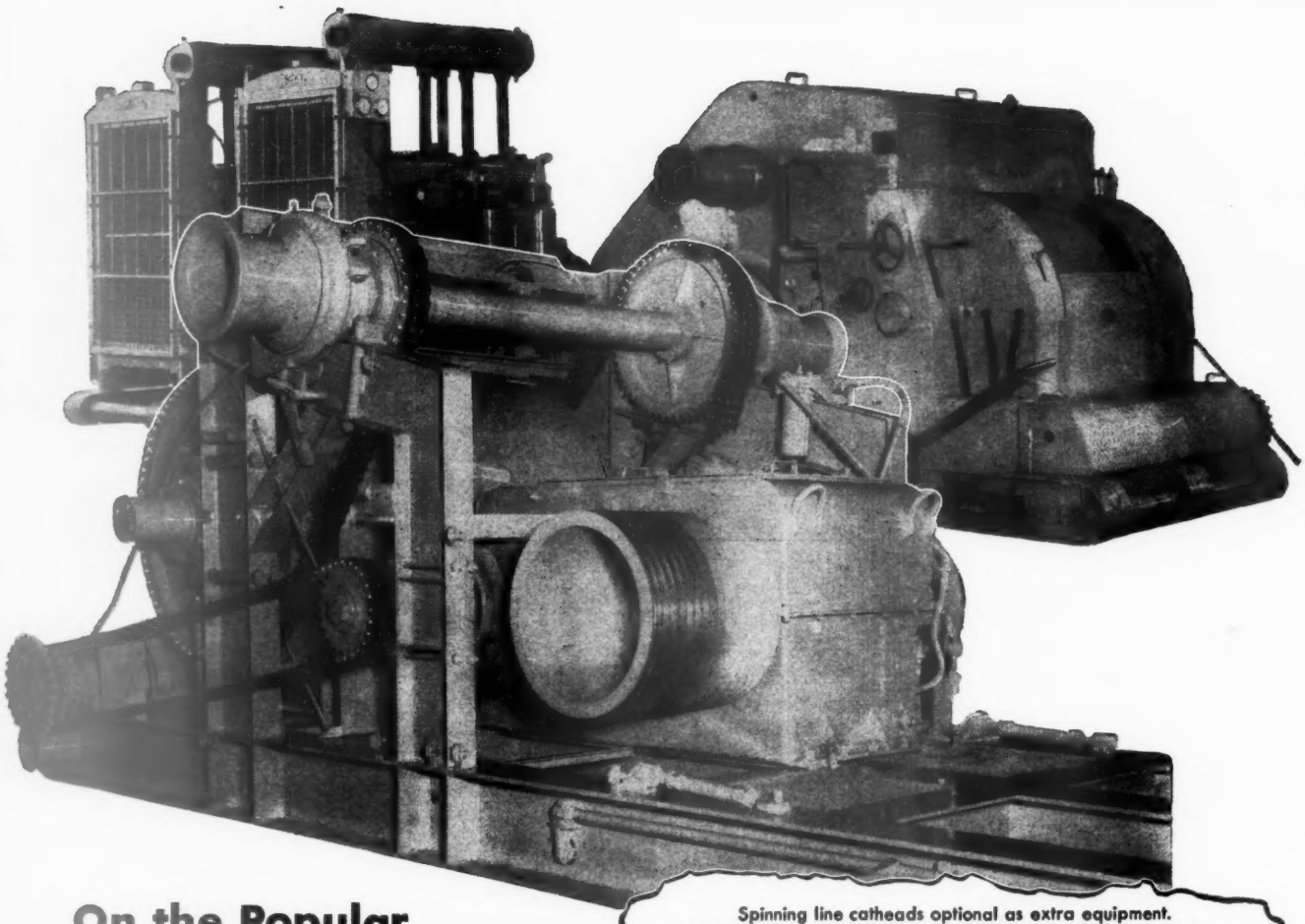

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DIAMOND ROLLER CHAINS

GAS LIFT DESIGN, INSTALLATION, AND OPERATION

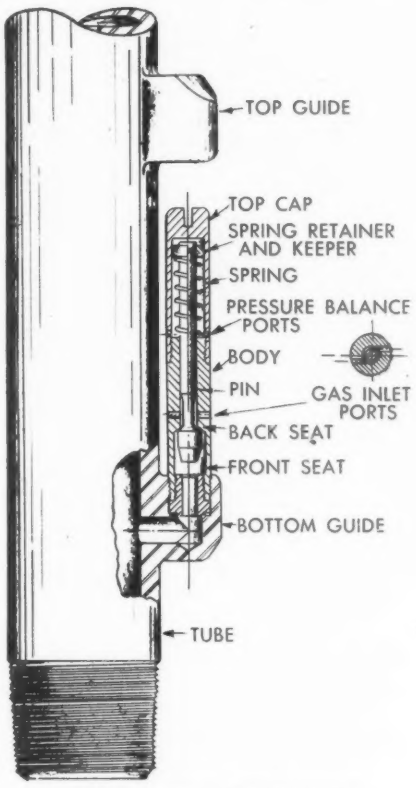


FIG. 1. Automatic differential controlled flow valve.

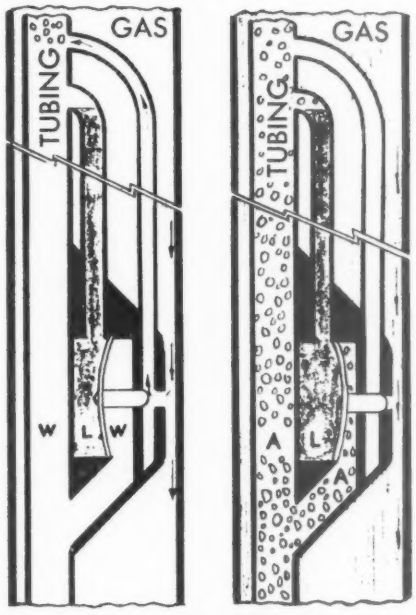


FIG. 2. Specific gravity controlled valve.

W—Well fluid in tubing.

L—Light oil which functions as a counter weight in the mechanism and which is placed in the 16 ft "oil tube" of the valve prior to running in the hole.

Note: The light oil is open to the inside of the tubing at the top of the oil tube but is so arranged that no mixture takes place.

A—Aerated well fluid.

BECAUSE W IS GREATER THAN L:

Well fluid weighing against the right side of the diaphragm exerts a greater pressure than light oil and well fluid weighing against the left side of the diaphragm. This forces the diaphragm to the left—opening the valve.

BECAUSE A IS LESS THAN L:

Aerated well fluid weighing against the right side of the diaphragm exerts less pressure than light oil and aerated well fluid weighing against the left side of the diaphragm. This forces the diaphragm to the right, closing the valve.

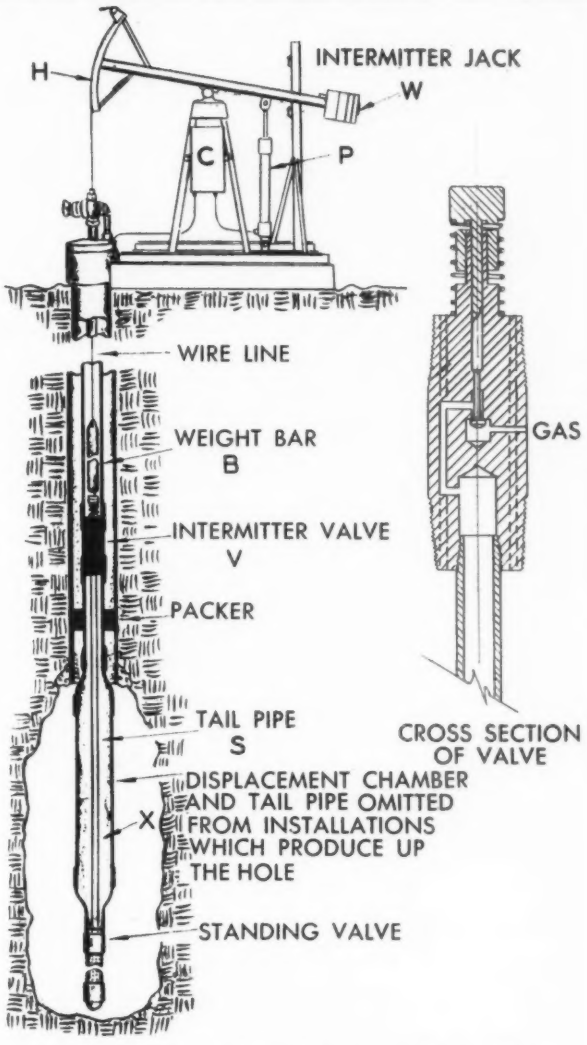
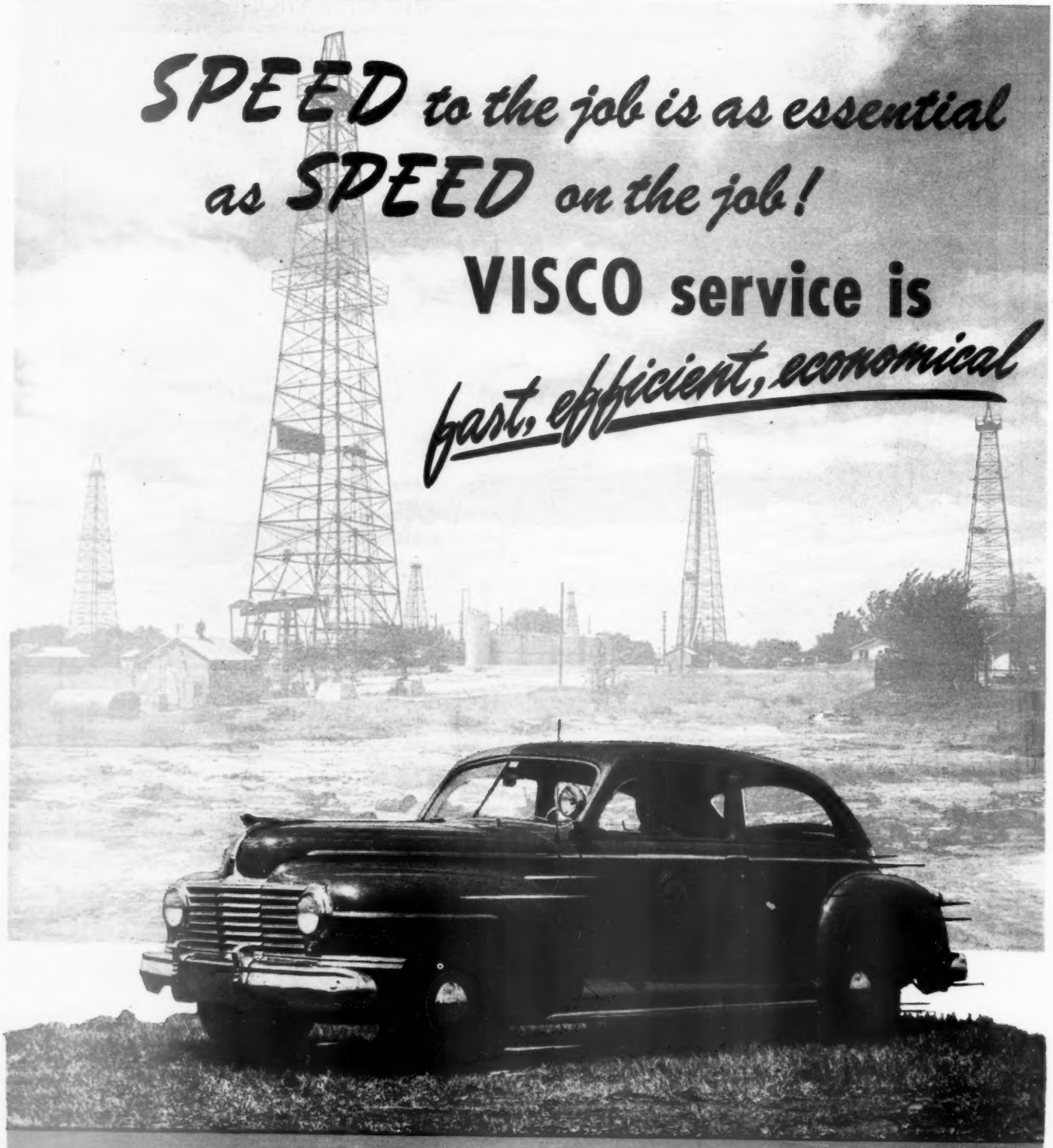


FIG. 3. Wire line controlled intermitter valve.

For every type of well there is a type of gas lift equipment most suitable. Automatic differential controlled flow valves are suitable for rates greater than 40 bbl an hr, and lifts of less than 2500 ft. Surface controlled intermitters are suitable for any depth and rates from 1 bbl a day up to 400 bbl a day in 2-in. tubing, and 1000 bbl a day in 2½-in. tubing. Other types of valves are available for varying well conditions.

(See following sheets for further description.)

NOTE: *These data are taken from the article, "Design, installation, and operation of gas lift equipment," by Louis F. Davis, in the December, 1946, issue of* The Petroleum Engineer, *pages 60 to 77, inclusive.*



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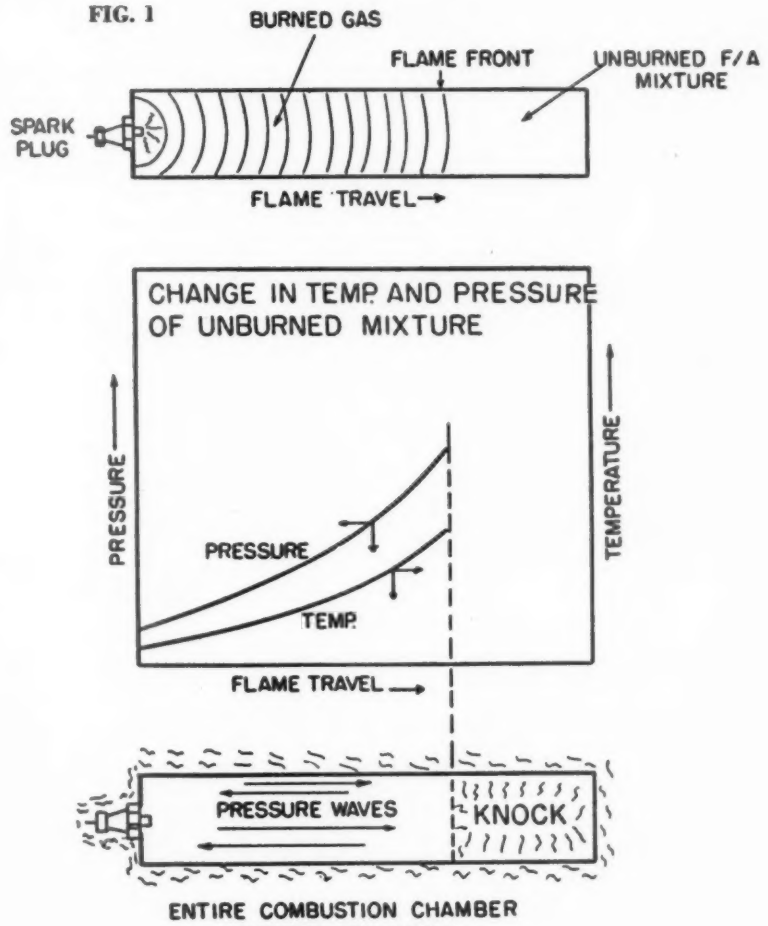
IGNITION AND KNOCK CHARACTERISTICS OF HYDROCARBON FUELS

According to our present knowledge, knock is caused by the spontaneous ignition or disintegration of the unburned portion of the charge. If the fuel is ignited in the cylinder, and it burns slowly enough so that the energy build-up in the unburned portion is not fast enough to cause spontaneous ignition, a smooth combustion will take place. On the other hand, if the rate of burning is too fast, or the spontaneous ignition temperature (S.I.T.) of the charge is very low, the combustion will proceed across the cylinder until the energy build-up in the unburned portion reaches the critical conditions for its spontaneous ignition, whereupon a simultaneous explosive combustion of that portion occurs, resulting in a detonation wave commonly known as knock. This is illustrated[1] in the lower part of Fig. 1.

In the case of diesel engines, no spark is employed and the combustion proceeds almost entirely through the means of spontaneous ignition, so that it can be expected that spontaneous ignition data obtained under engine conditions should correlate somewhat better with knocking data, and such has been found to be the case in some Russian[2] work, as shown in Fig. 2. In those experiments, engine conditions were estimated to be 580 C and 215 atm., and the time lag before ignition in a bomb under those conditions was measured for various fuels and found to correlate quite well with cetene numbers. Other workers[3] at the time concluded, however, that the measurement of time lags to a fraction of a millisecond was not readily adaptable for routine laboratory evaluation.

In the case of spark ignition, the combustion is more complex, so that it would be surprising if S.I.T. data alone showed any sort of a correlation. Fig. 3 gives some typical S.I.T. data obtained for n-butane by Townsend et al[4] some years ago. Due to the technique of preparing samples, detailed information was obtained mostly on the gaseous hydrocarbons. It can be seen that, at low pressures, the S.I.T. falls in a high temperature range, over 500 C; but at a critical pressure, in this case 1.75-2 atm., the S.I.T. drops to a lower range, 300-400 C and remains there upon further increase in pressure. This critical zone is exhibited by most compounds except the very stable ones such as methane, benzene, and toluene. It has been explained by the fact that the increased pressure stabilizes the intermediate oxidation products formed. According to these data, then, the S.I.T. decreases with increase in pressure and with increase in F/A ratio, at least in the engine mixture zone.

FIG. 1



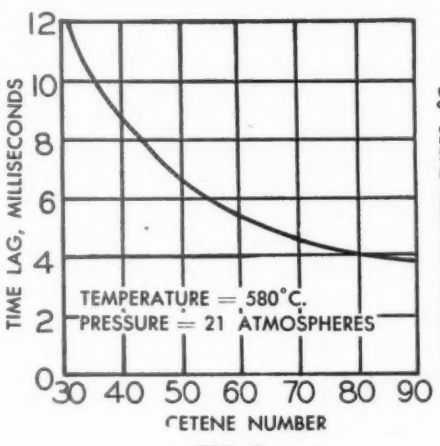


FIG. 2

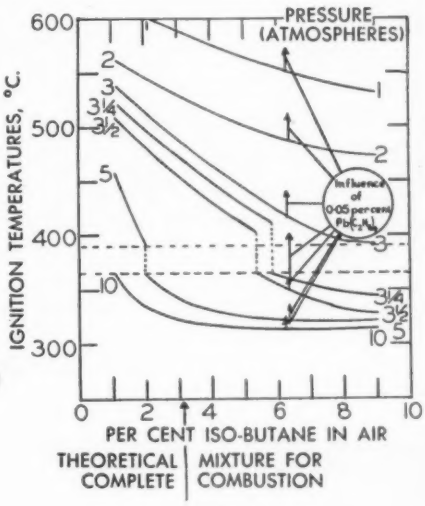
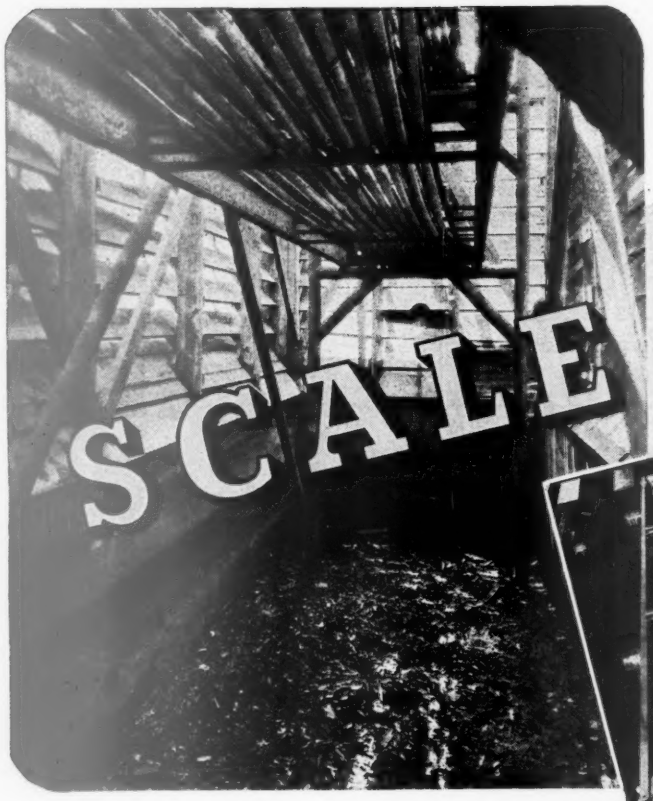
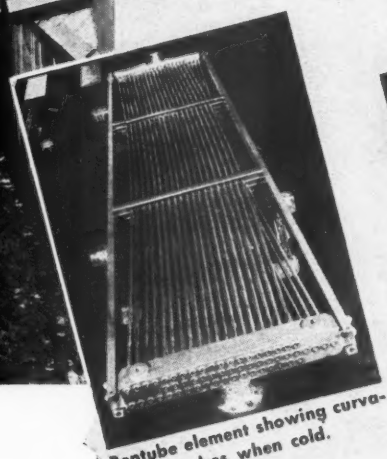


FIG. 3

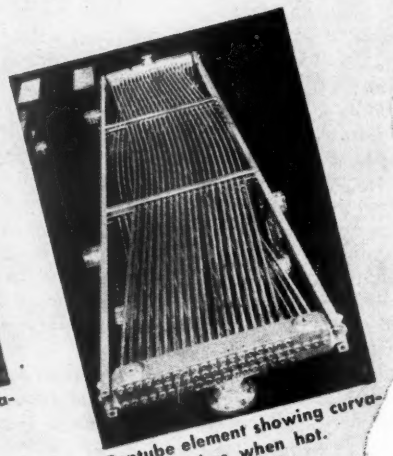
Note: References are shown on the last sheet of this series. Taken from the article, "Knock-free power," by Peter J. Gaylor in the December, 1946, issue of *The Petroleum Engineer*, pages 43 to 48, inclusive.



SCALE is no problem...



Bentube element showing curvature of tubes when cold.



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GAS LIFT DESIGN, INSTALLATION, AND OPERATION

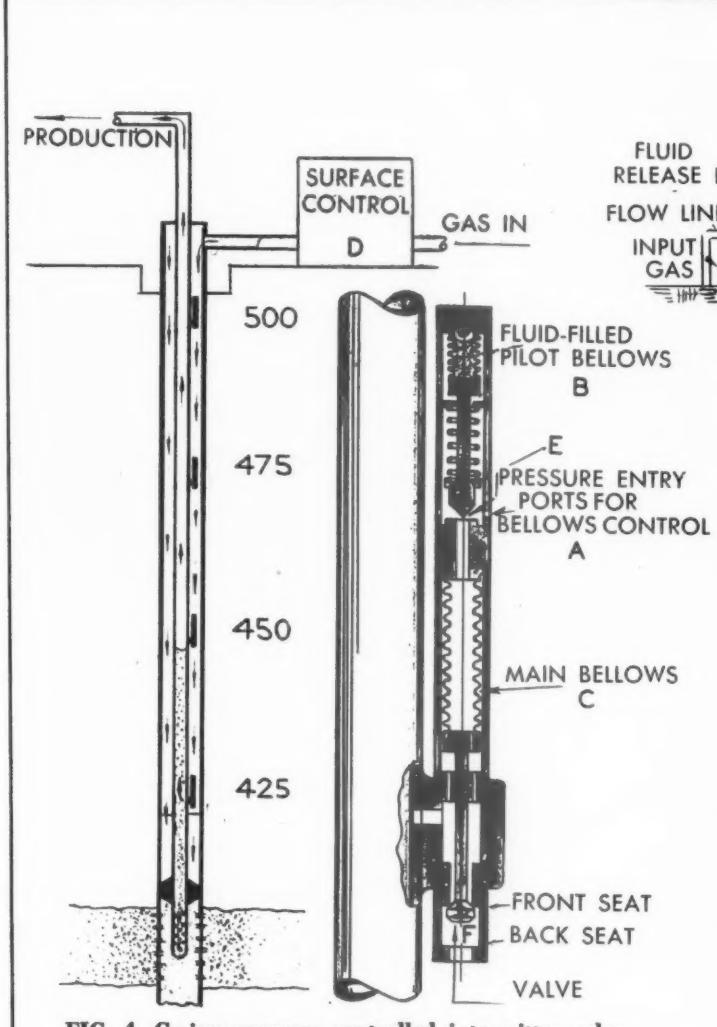

FIG. 4. Casing pressure controlled intermitter valve. (Figures are lb. per sq. in.)

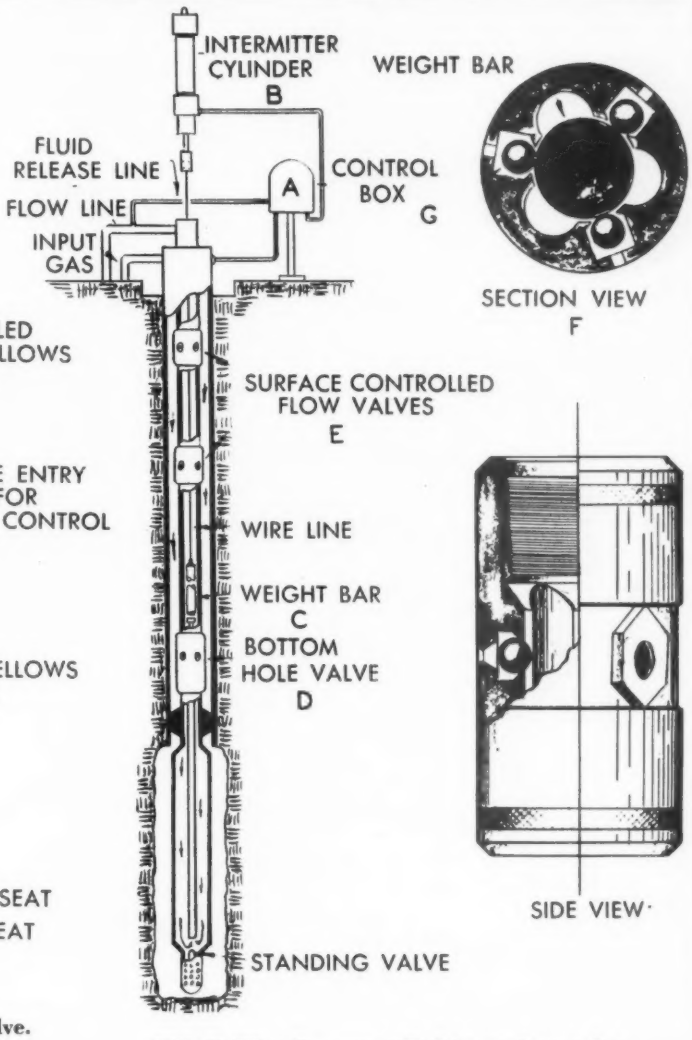

FIG. 5. Wire line controlled intermitter valve.

In general, gas lift equipment may be divided into three main types: (1) The automatic differential controlled flow valve, (2) the specific gravity controlled flow valve, and (3) the surface controlled intermitters and flow valves.

A type of automatic differential controlled flow valve is illustrated in Fig. 1. The valve is given a differential by the action of the spring, which added to the weight of the column of liquid inside the tubing, opens the valve against the pressure of the gas in the annular space between the tubing and casing. This spring induced differential is ordinarily 100 lb per sq in. This figure was obtained by extensive experiments and field trials that proved its desirability over larger or smaller differentials. With smaller differentials, it is difficult to obtain the velocity of fluid travel needed for efficient operation, whereas larger differentials tend to cause excessive gas consumption, for the valves are difficult to close.

Examination of Fig. 1 shows that normally the pressure in the casing holds the valve shut against the action of the spring, which rests on the front seat. As liquid builds up in the tubing above the valve, its pressure is added to the force of the spring until a sufficient amount has accumulated to open the valve against the casing pressure. Gas is then injected and the fluid in the tubing lifted to the surface. As the liquid is produced, the pressure in the tubing again declines and the valve shuts pending further accumulation in the tubing.

The valves are set from 225 to 400 ft apart, depending on the fluid to be lifted, differential, and position in the hole with relation to the working fluid level.

The specific gravity controlled valve is illustrated in Fig. 2. By examination of this figure it becomes apparent that so long as liquid W of a specific gravity greater than that of liquid L, with which the valve tube is loaded, is opposite the valve in the tubing, the valve will remain open. Valves above that one producing and hence opposite a light fluid column such as A, will positively remain shut so long as an aerated column is moving past them.

A surface choke can be used with the specific gravity valve without changing valve opening characteristics. These features make the specific gravity control more suitable for the deeper wells where a considerable number of valves are installed. The number of valves is also reduced due to the elimination of the differential. Valves can be set a considerable distance apart, depending on the casing pressure, fluid to be lifted, etc.

Three types of surface controlled valves are illustrated in Figs. 3, 4, and 5. Figs. 3 and 5 illustrate the wire line controlled intermitter, and in that illustrated in Fig. 4 the casing pressure is the controlling factor. (See other sheets in this series for further reference.)

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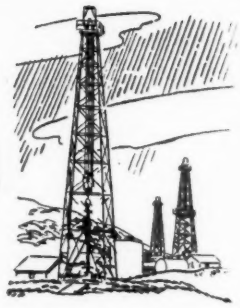

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CHAIN BELT COMPANY of MILWAUKEE

IGNITION AND KNOCK CHARACTERISTICS OF HYDROCARBON FUELS

Addition of TEL to the fuel raises the S.I.T., the effect being less at higher pressures, except within the critical zone (as can be seen from Figs. 3 and 4), when the increase may amount to 150 200 C. The data for iso-butane are similar, except that they are at a higher temperature level and the temperature gap in the critical zone is considerably narrowed (see Fig. 4).

Brown[5] determined the maximum rate of rise of pressure, $\frac{dp}{dt}$ in the spark explosion of a number of fuels, and indicated a correlation between knocking tendency and the product of $\frac{dp}{dt}$ with the inverse of the S.I.T. His data for the seven fuels tested are shown in Fig. 5. Some correlation is apparent despite the fact that the working range is very narrow, but it is not understood why he used atmospheric S.I.T. data when he went to the trouble of obtaining explosion pressures.

It might be remarked here that flame speed is not the same thing as combustion speed when we are talking about a particular portion of a single stroke. The correlation between the two for a particular fuel has been shown by Boyd[6] to be as in Fig. 6. In other words, the percentage of the mass burned is less than the volume inflamed, although it speeds up quite rapidly at the end of the stroke. Hence, $\frac{dp}{dt}$ would be a more accurate measurement of heat build-up than flame velocity.

It so happens, however, that very meager data have been published on pressure rise curves of pure fuels, and some (though meager) data do exist on flame speeds for hydrocarbons under conditions found in the engine. Fig. 7 shows[7] flame speeds of benzol-air mixtures at 20 atm. ga. and 100 C, the maximum speed being somewhat above 0.1 F/A. Fig. 8 shows that initial temperature increase lowers the maximum flame speed and moves the peak to the lean side. In Fig. 9 it is shown that TEL lowers flame speed, the effect being most marked at the maximum speed point.

Some rather skimpy laboratory data are also available on the S.I.T. of pure hydrocarbons and blends under engine conditions. The method employed for obtaining the data consisted of weighing out accurately a sample of the fuel to be tested in a sealed glass capsule, which is crushed in a closed system by a plunger and preheated air from a calibrated reservoir is allowed to carry the fuel vapors into the heated calibrated ignition bomb. Ignition is observed by rise in temperature indicated by a fine iron-constatan thermocouple in the center of the bomb.

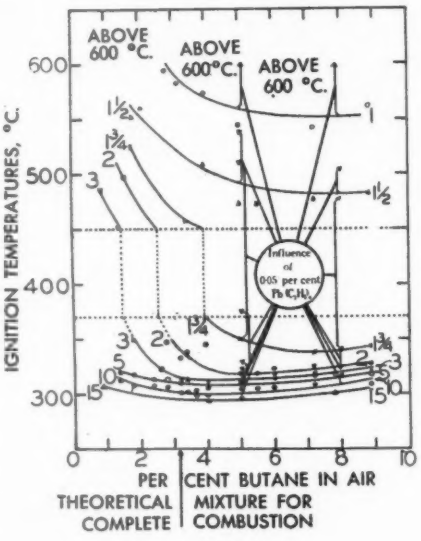

FIG. 4

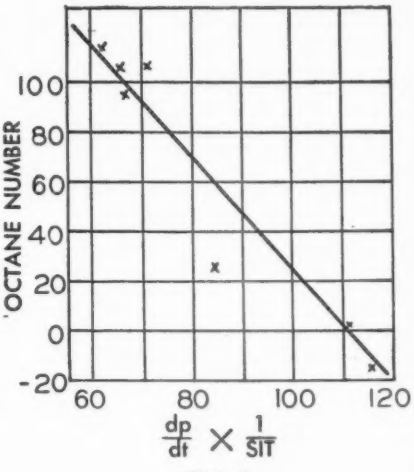

FIG. 5

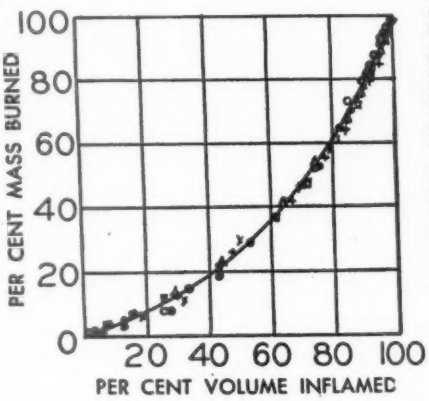

FIG. 6. How volume inflamed relates to mass burned.

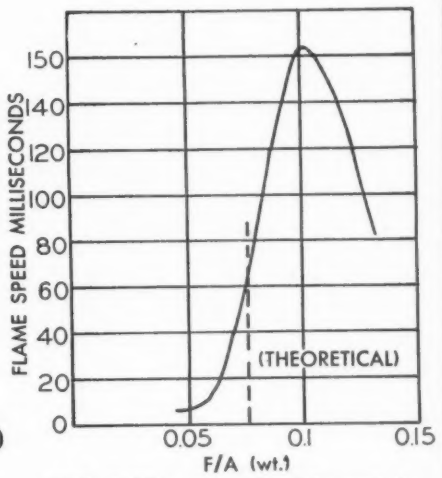

FIG. 7. Flame speeds of benzol-air mixtures at 20 atmospheres gage and 100°C.

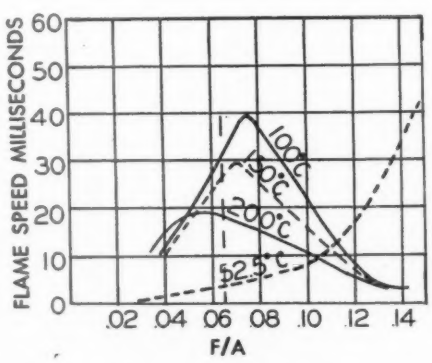

FIG. 8. Flame speeds of gasoline-air mixtures at 20 atmospheres gage.

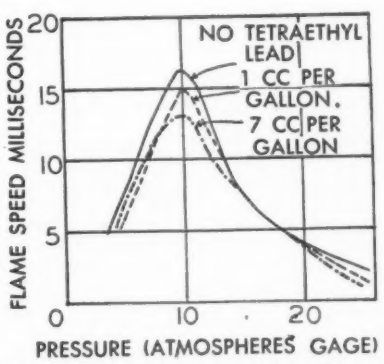

FIG. 9. Effect of tetraethyl lead on flame speed of gasoline-air (0.09 F/A 50°C).

Note: References are shown on the last sheet of this series. Taken from the article, "Knock-free power," by Peter J. Gaylor in the December, 1946, issue of *The Petroleum Engineer*, pages 43 to 48, inclusive.

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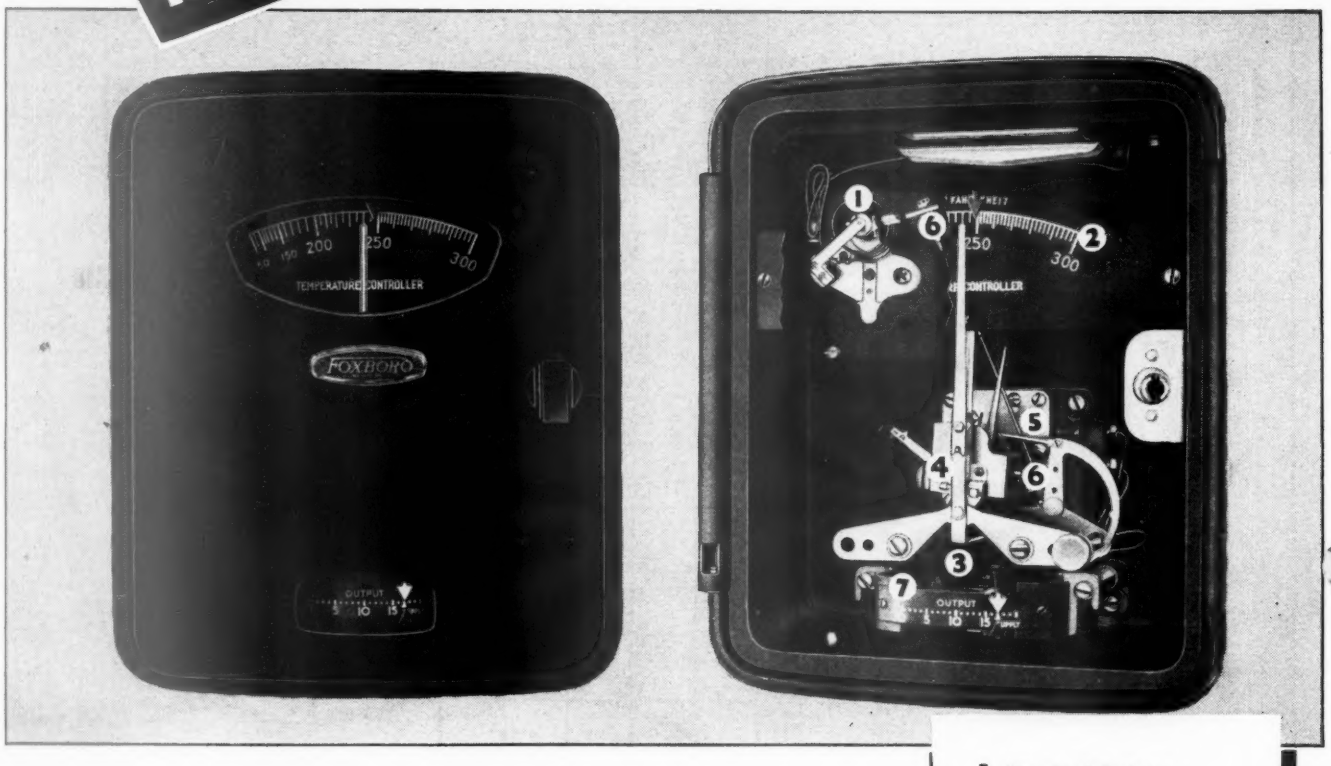

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2. 4" Scale
3. Sturdy, simple easy-to-remove control unit
4. Proportioning Mechanism that moves on single center of motion as control setting knob is changed.
5. Control Relay . . . same as M-40
6. Exclusive Foxboro Ball Linkage
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Rotax (electric) Controllers in matching cases also available.

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Instrumentation

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GAS LIFT DESIGN, INSTALLATION, AND OPERATION

Where the wire line type is used, some means must be available of unloading to the bottom intermitter valves. With the type of wire line system illustrated in Fig. 5 this is done by successively moving the weight bar through the various valves in the string until the proper valve is reached. With the intermitter shown in Fig. 3, automatic differential valves are used where necessary as kick-off or unloading valves.

The surface jack shown in Fig. 3 is equipped with a time cycle control "C." This can be set to admit gas at various intervals to cylinder "P." This lifts a piston that through a rod raises the weights "W" and pivots the jack so that the head "H" and wire line are lowered. This allows the sinker bar "B" to rest on the intermitter valve "V," open it and permit gas to flow from the tubing-casing annulus into the tubing tail pipe "S" and lift the fluid in the chamber "X."

In cases where the working fluid level in a well is high, the intermitter can be set up the hole, and the tail pipe and accumulation chamber omitted.

Operation of the pressure controlled intermitter valve illustrated in Fig. 4 is as follows: Surface control D admits gas to tubing casing annulus. This pressure rise is passed through port A to outside of bellows B and lifts pilot valve E off seat, admitting gas to main bellows C, which opens valve F and allows gas to enter tubing. As illustrated in Fig. 4, valves are spaced in the hole with each valve down hole opening at a lesser pressure than the valve above it, so that valves above gas-oil contact in annulus are shut and remain so regardless of pressure or contents in tubing.

Referring to Fig. 5, control box A admits gas to cylinder B, raising piston attached to wire line, which lifts weight bar off bottom valve D and thus allows gas to pass into tubing from tubing-casing annulus. Upper valves E are opened by raising bar into valve as shown in Section F and pushing balls G off their respective seats.

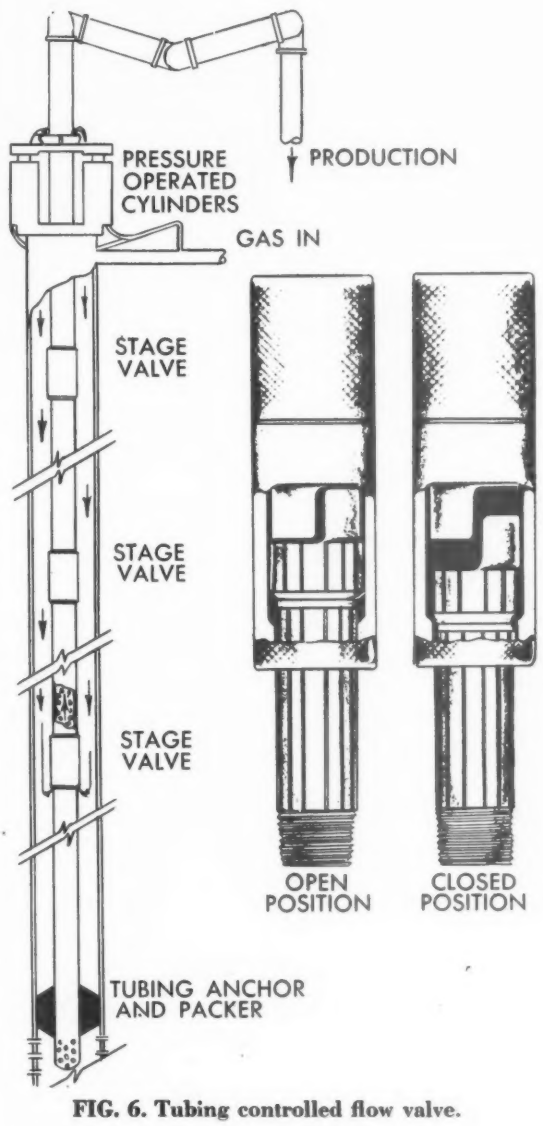

FIG. 6. Tubing controlled flow valve.

The valve illustrated in Fig. 6 is operated by raising or lowering the string of small tubing on which it is installed. The tubing is anchored at the bottom and its manipulation is accomplished by the use of a screw lift or a hydraulic lift. With the tubing suspended from the surface, all valves are closed, and as the weight is transferred to the anchor by "slackening off," the valves open, the bottom valve opening first. By calibrating the surface lift, any desired valve, and those below it, can be opened.

● **Installation design.** The first step in the selection of gas lift equipment is the determination of the conditions under which it will be operated. This involves a detailed study of the well in question. One must determine its productive capacity, both present and future, and both oil and water. The producing level must be obtained from tests, calculated from the productivity index or estimated. A forecast must be made of the allowable, and of the probable rate of future gross liquid production, and of the depths from which it must be. A study must also be made of the gas supply in the area to determine whether it will be available consistently over a period of years.

Next comes the selection of the operating gas pressure.

Generally speaking, the higher the pressures that can be used, the greater the efficiency that will be obtained. This increase in efficiency is due to the reduction in slippage, which is proportional to the velocity obtained, which in turn depends on the pressure available for lift. A handy rule of thumb is to use a minimum 100-lb pressure for every 1000 ft of depth and a minimum pressure of 250 lb per sq in. regardless of depth. Under this rule, wells 2000 ft in depth would be lifted by 250-lb pressure and those 8000 ft by 800-lb pressure. Each case, however, must be carefully checked so that efficient lift is not obtained at the cost of exorbitant compression charges.

Next, the depth of the producing valve must be determined. This depth equals the producing level at the rate desired, plus the valve submergence. The submergence can be obtained by dividing the available gas pressure minus 100 lb per sq in. by the weight of the fluid to be lifted in lb per sq in. per ft of height. The spacing of the upper or unloading valves is then determined as explained on sheet 4.

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IGNITION AND KNOCK CHARACTERISTICS OF HYDROCARBON FUELS

Fig. 10 shows how the flame speed of benzene differs with pressure in comparison with that of toluene (at 0.09 F/A and 50 C), and Fig. 11 is illustrative of the technique employed to determine the borderline of ignition at 19.3 atm. ignition bomb pressure. The circles indicate no immediate ignition, and the crosses denote ignition taking place, the line marking the border between the two. Fig. 12 shows the results obtained at 19.3 atm. bomb pressure with an aromatic, isoparaffinic, naphthenic, and paraffinic hydrocarbon. The data for toluene are not very reliable, for the conditions required for the hydrocarbon should really have necessitated a modified apparatus.

As can be seen from Fig. 12, the S.I.T. is essentially a "stability index." The data on the clear fuels are in line with those of Townsend mentioned previously.

The S.I.T. data on antiknock blends given in Fig. 13 are quite interesting. It will be observed that xylidine raises the S.I.T. of heptane considerably, that of isooctane less, and actually lowers the S.I.T. of toluene some 60 C. TEL, on the other hand, appears to somewhat lower the S.I.T. of heptane in the lean end and raise it somewhat in rich mixtures. It raises the S.I.T. of isooctane in all ratios, and affects toluene in the same way as heptane, but more so. Of course TEL is a fairly unstable substance. Its S.I.T. is about 150 C, and addition to a fuel of 300 C S.I.T. (at atm. press.) raises the S.I.T. to a peak of 4 0 C at 15 per cent concentration[10]. TEL, as such, is ineffective as an antiknock. Only in its decomposed state is it effective[11]. Apparently the effect is due to lead atoms rather than the organic groups. Pronocks lower the S.I.T.

The xylidine results might be explained on the basis of stability of the compound. P-xylidine decomposes appreciably under its own pressure at 318 C, so one would expect it to decompose more and more as the temperature level is increased.

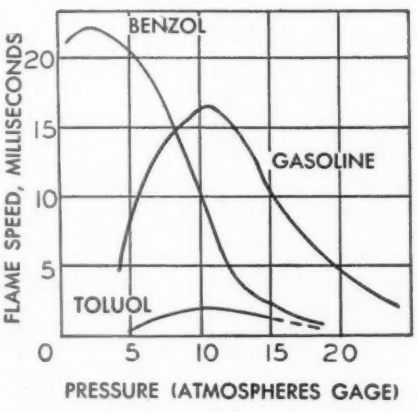


FIG. 10. Flame speeds (0.09 F/A, 50°C) in air.

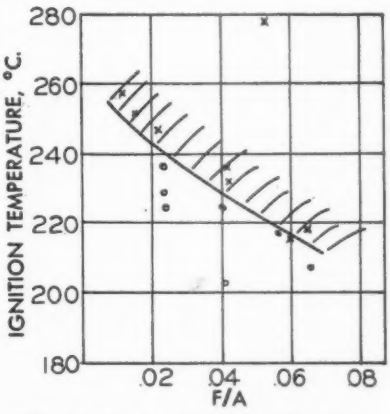


FIG. 11. Spontaneous ignition temperature of N-heptane in air (19.3 atmospheres bomb pressure).

Note: References are shown on the last sheet of this series. Taken from the article, "Knock-free power," by Peter J. Gaylor in the December, 1946, issue of *The Petroleum Engineer*, pages 43 to 48, inclusive.

FIG. 12. Spontaneous ignition temperature of hydrocarbons (19.3 atmospheres pressure).

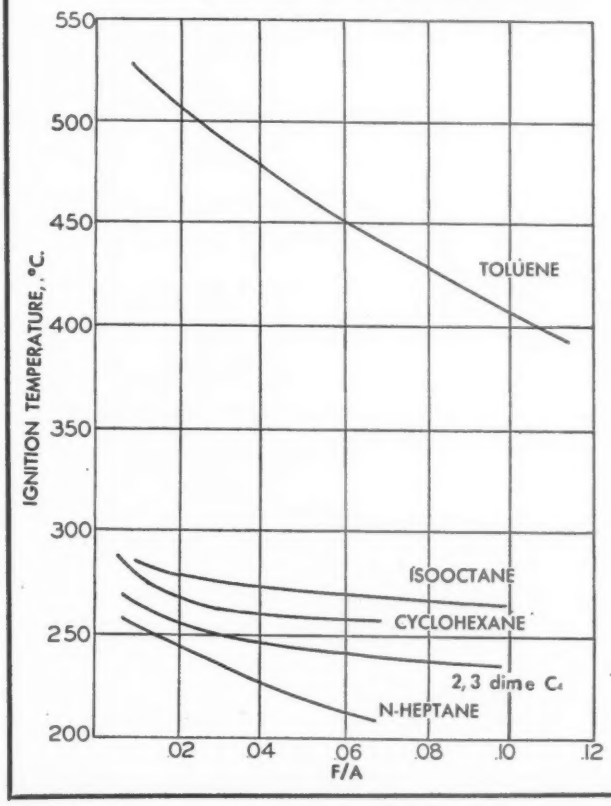
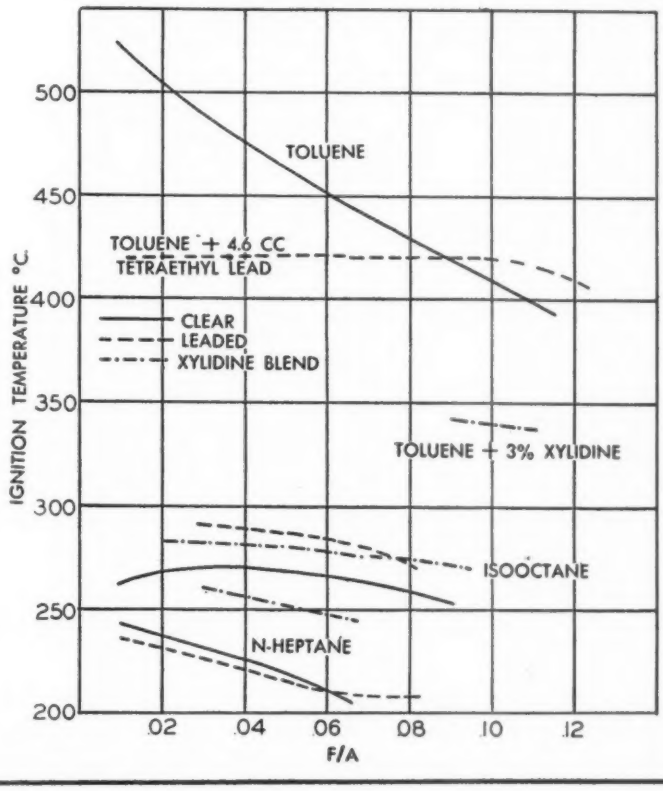
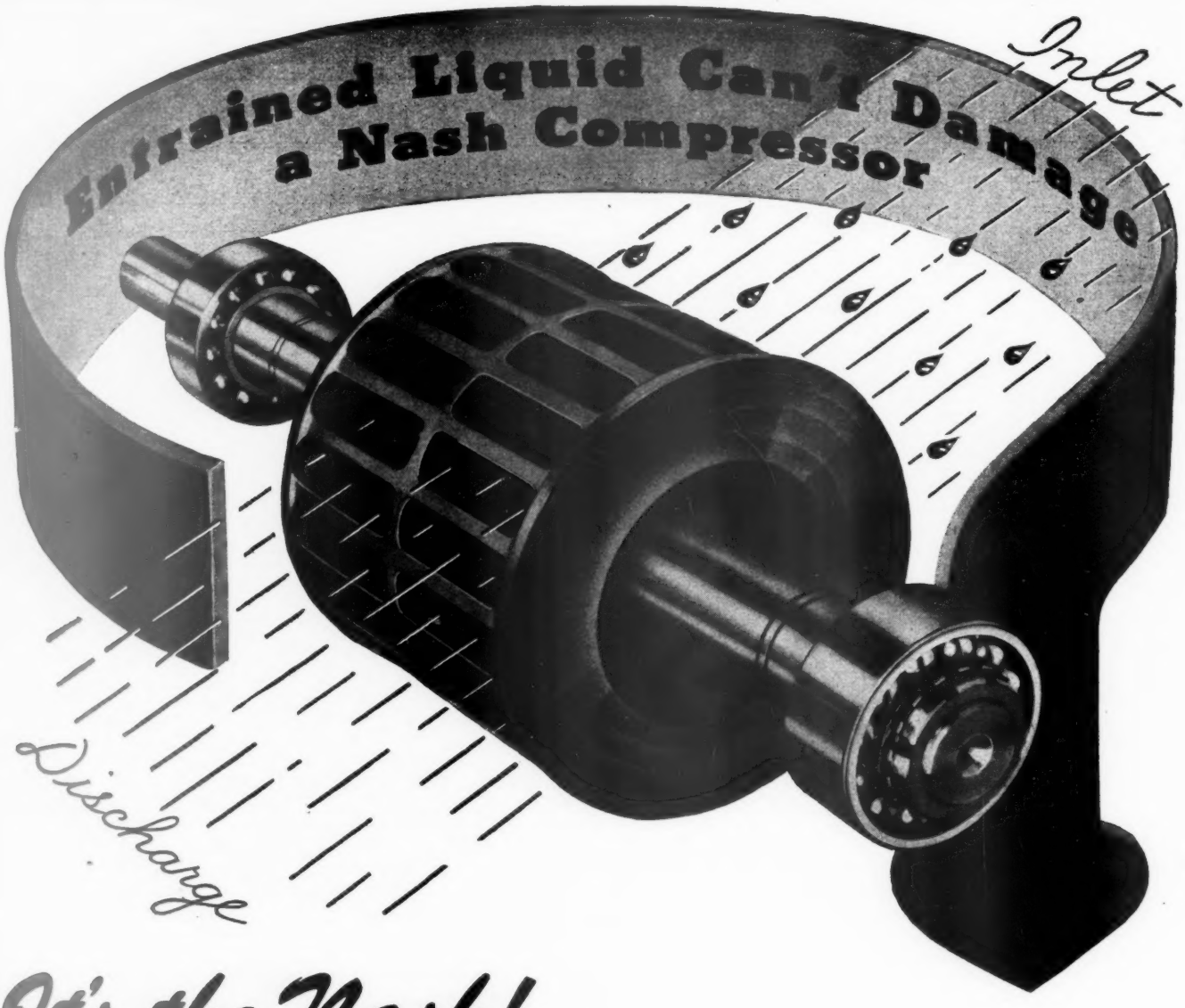


FIG. 13. Spontaneous ignition temperatures blends (19.3 atmospheres pressure).





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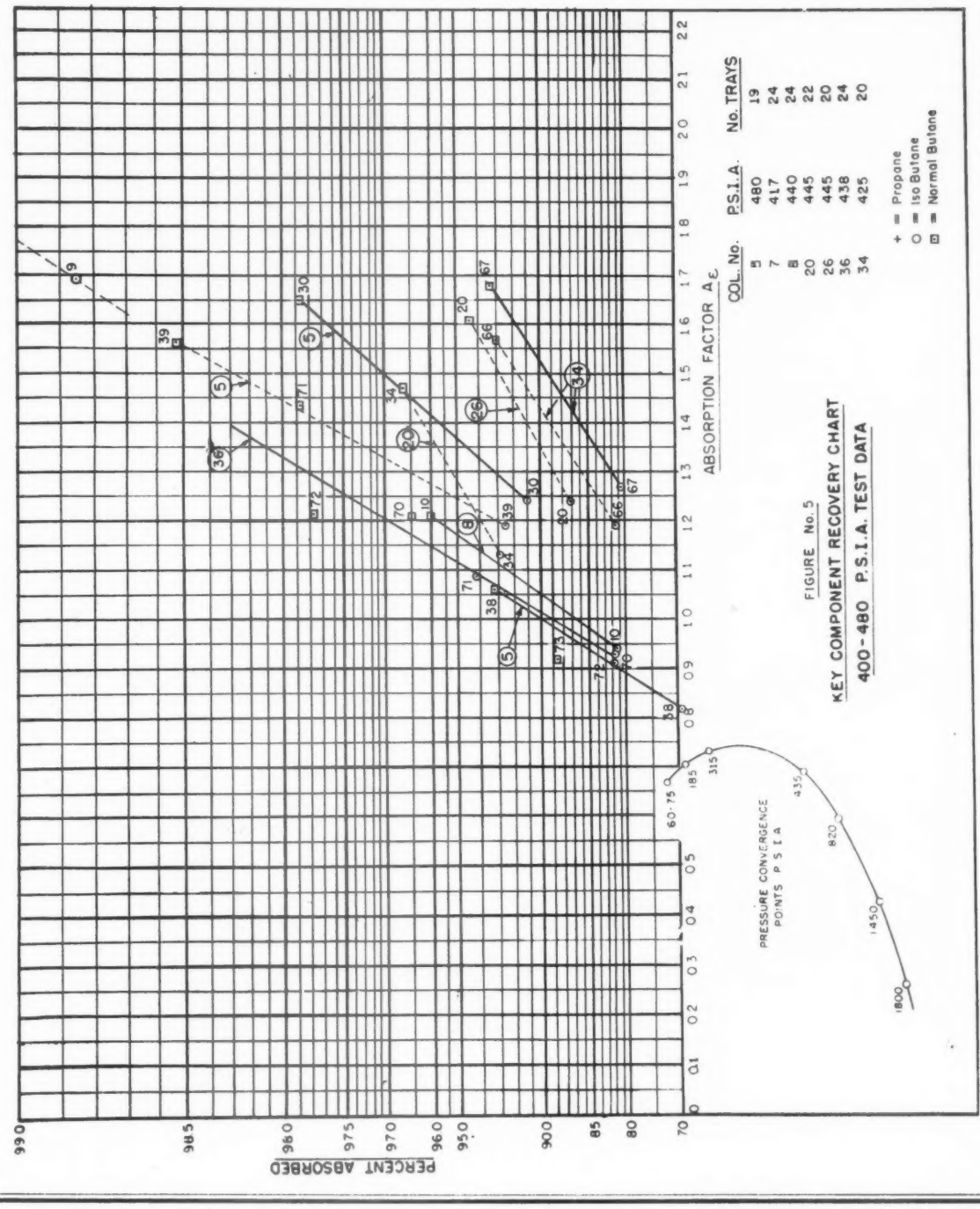
The facts obtained from the group plots (Figs. 2 and 3) led directly to the development of the special "straight-line" Key Component Recovery Charts (Figs. 4 and 5).

With these charts, all component recoveries between 75 and 99 per cent plot as a straight line for any given column so long as its basic tray efficiency remains constant. Furthermore, all such straight lines, irrespective of number of trays employed or degree of efficiency, can be drawn through a single convergence point for any given absolute pressure with an accuracy well within that required for precise engineering work. Finally, the characteristic operating lines remain fixed for any given column over wide ranges of lean oil temperatures, and for all types of intercooled columns so long as the intercooling is confined to the upper 75 per cent of the columns.

(For further explanation, see other sheets of this series.)



—Taken from the article by E. G. Ragatz and J. A. Richardson in the December, 1946, issue of The Petroleum Engineer, pages 53-58, inclusive.

New 2½" to 4" GEARED PIPE THREADER

that's a cinch to work with RIDGID No. 4P

Loop handles make it easy to pick up

easy to carry

easy to put on pipe

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● **Harold F. Ormston,** supervisor in charge of the transportation and material distribution division of the production department, Humble Oil and Refining Company, has resigned to enter the transportation business. Ormston and his associates purchased the Hill & Hill Truck Line, Houston, Texas, of which Ormston is to serve as manager. **N. B. Robins,** assistant division chief clerk of the East Texas division, Tyler, has been transferred to the production operating department, Houston, as assistant chief clerk. **Rex Williams,** assistant division chief clerk, Louisiana division, New Orleans, was transferred to the East Texas division, Tyler, replacing Robins. **M. B. Donnell,** assistant division chief clerk, Southwest Texas division, Corpus Christi, was transferred to the Louisiana division, New Orleans, to replace Williams.

● **Henry P. Matthews, Jr.,** Dallas accountant, announces a service to the oil industry that he feels will be helpful to non-operators. His service consists of auditing and booking joint interest statements. Matthews was connected with the Magnolia Petroleum Company in general accounting for more than 20 years, eight of which were spent in the Oklahoma and Gulf Coast fields as a machine shop cost accountant and material man.

● **David E. Johnson** has been appointed a vice president of The Steel Improvement and Forge Company, Cleveland, Ohio. Johnson has been in charge of all production operations of the company as superintendent for many years.

● **G. A. Tompson,** vice president, **R. G. Ayers,** general manager of sales, **R. G. Petri,** auditor and assistant secretary, **A. W. Tarkington,** assistant treasurer, **F. J. Eaton,** Tulsa plant manager, and **I. C. Smith,** Corsicana plant manager, all of Bethlehem Supply Company, have returned from a trip east during which they visited the home office of the Bethlehem Steel Corporation in Bethlehem, Pennsylvania. R. G. Ayers extended his trip to include other points in the east contacting the trade.

● **L. H. Butterworth,** assistant general foreman in the light oils division of the Whiting, Indiana, refinery of Standard Oil Company (Indiana), has been promoted to assistant general superintendent of the company's Casper, Wyoming, refinery. Butterworth joined Standard of Indiana in 1937 as a chemical engineer in the research department at Whiting. In 1942 he was transferred to the manufacturing department as an assistant general foreman in the light oils division at Whiting, serving first in the light oils finishing department and later in the crude stills department. He received his bachelor of science in chemical engineering from the University of Iowa.

● **Herbert V. Evans, Jr., and H. C. Grieme** have joined the sales department of Alloy Steel Products Company, Linden, New Jersey. Evans began his career in the steel industry with Lebanon Steel Foundry. After his return from service in the Army Air Forces he represented Anticorrosive Metal Products Company, Inc., in New England. Grieme, with the Bureau of Ships, U.S.N., during the war, previously was engaged in purchasing work with Chemical Construction Corporation, H. K. Ferguson Company and Campbell Soup Company.

● **Warren Bailey,** ex-Captain AAF, and **D. M. McCargar** have opened an office and warehouse in Corpus Christi, Texas, for Brance-Krachy Company, Inc., and have Falk Corporation, The Louis Allis Company, Electrical Machinery Manufacturing Company, Reeves Pulley Company and Transco on a direct factory representation. They also will handle Whitney Chain and Goodrich "V" belts as distributors.

● **Robert K. Franklin,** owner, Rolo Manufacturing Company, left February 19 for a six weeks' visit in South America. Most of his time will be spent in Venezuela and Colombia. Franklin has about 12 years' experience designing and servicing oil-well metering equipment. He is the designer of the Rolo Wellchecker, which his company manufactures. Rolo Wellcheckers, introduced in 1945, are test separators and metering units that gauge and record potential gas flow, oil ratios, and BS&W content of flowing wells.

● **C. F. "Fred" Royse,** formerly with the Griscom-Russell Company, has been appointed district engineer of The Fluor Corporation, Ltd., in charge of its Houston, Texas, office. Royse is a native Texan, graduating from Rice University with a degree in chemical engineering. Upon graduation he worked for the Humble Oil and Refining Company for more than five years. After Humble, he went to G-R for approximately the same length of time. He was in the Houston area with these two firms.

C. F. Royse

● **C. B. Claypool,** for the last 11 years Gulf Coast geologist for Sun Oil Company, has resigned to open an office in the American National Bank Building, Beaumont, Texas, as a consulting geologist and geophysicist. He will be associated with **Gordon I. Atwater,** consulting geologist of New Orleans. They will also continue the New Orleans office.

● **R. W. Stueve,** formerly general supervisor of labor relations for American Car and Foundry Company, has been appointed assistant comptroller for the company.

● **Major William B. Campbell,** formerly with the Army Air Forces, has been appointed general sales supervisor by Sperry-Sun Well Surveying Company, with headquarters at Houston. Prior to World War II Major Campbell was sales promotion and advertising manager, also export manager for Dowell, Incorporated, Tulsa, Oklahoma. He began his oil field career with Phillips Petroleum Company as general sales manager of Philfuels Company, a Phillips Petroleum subsidiary. When Phillips Petroleum Utilities Company was organized he was made general manager. Major Campbell was later an independent oil operator in the Mid-Continent.

W. B. Campbell

● **Guy Marion Shipley** was recently employed by the Houston Oil Field Material Company, Inc., as directional drilling engineer. He will be stationed at Odessa, Texas, and will work in the West Texas area. Shipley has spent the last five years in this area where he has been connected with directional drilling service. He is well experienced in drilling conditions in that district.

● **Vance M. Scott** of Perry, Oklahoma, has been appointed U. S. Steel's Tennessee Coal, Iron and Railroad Company farm products agent for Oklahoma. Scott was graduated from Oklahoma A. & M. with a B. S. degree in animal husbandry in 1938. Recently he has been county agent for Nobel County, Oklahoma.

● **M. E. Tolleson** and **C. A. Houy** have been promoted to vice president in charge of oil production and vice president in charge of gas production, respectively, of the Republic Natural Gas Company, Dallas, Texas. Tolleson has been with Republic Natural or its predecessor companies since 1930 and has had wide experience in gas measurement, drilling operations, and oil production in Texas and Kansas. Before his promotion, Tolleson was superintendent of the oil division of the company. Houy joined the company as a junior engineer in 1941. Before his promotion he was superintendent of the gas division of the company with supervision of Gulf Coast gas properties and all the extensive gas operations of the company in the Hugoton field in Kansas and Oklahoma.

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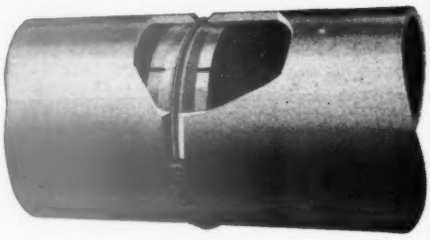
The use of WEDGE Chill Rings with the patented SPLIT Feature reinforces thin wall pipe for greater strength. It is for this reason that many progressive engineers responsible for installations of pipe and refinery lines specify thin wall pipe welded by this new, perfected method.



With it they get 100% penetration of every joint plus strong reinforcement by the WEDGE Chill Ring. Experience has proved that under shock, strain or vibration the pipe will fail before the reinforced joints. WEDGE Chill Rings assure a better job in less time, and at lower cost.

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WEDGE Split CHILL RINGS SAVE MONEY

● **Ritner W. Tomlinson** has been appointed superintendent of the Easton, Pennsylvania, plant of the Pennsylvania Salt Manufacturing Company. Tomlinson previously was plant superintendent of the Pennsalt plant at Cornwells Heights, Pennsylvania, and the Greenwich plant in Philadelphia.

● **Charles S. Redding,** president of Leeds and Northrup Company, manufacturers of electrical measuring instruments and heat treating furnaces, received the honorary degree of doctor of science at the mid-winter commencement exercises of the University of Pennsylvania. The degree was presented by Dr. George William McClelland, president of the university, from which Redding was graduated in 1906 and subsequently served for two years as a member of the faculty. He is an associate trustee of the university. He succeeded Morris E. Leeds, now chairman of the board, as president of Leeds and Northrup Company in 1939.

● **Fayburn L. Fox** has been appointed assistant secretary and head of the title and lease record department, and **J. W. Elder** has been made advalorem tax agent for The Ohio Oil Company. The appointments, made at a recent meeting of the board of directors, were effective March 1 with the retirement of **W. R. Hodge.**

● **A. P. Endres** has been made assistant to the public relations director of the General Petroleum Corporation. Endres, a Stanford graduate in 1933, has been with the concern eight years, mostly in the advertising and sales promotion department of the home office.

● **E. L. Downing** will be transferred to Dallas by Magnolia Petroleum Company as assistant general superintendent of production. **F. R. Corbell** will be transferred to Houston as assistant superintendent of the Gulf Coast division, succeeding Downing. **C. E. Taylor** goes to Alice, Texas, as superintendent of the Alice district, succeeding Corbell. **Harvey Lee** will be transferred to Brownfield, Texas, as superintendent of the Brownfield district, succeeding Taylor. The Jackson, Mississippi, district office has been closed.

● **F. H. Eaton,** formerly sales engineer, of American Car and Foundry Company, has been appointed assistant to vice president. **H. J. Russell,** sales agent, also has been appointed assistant to vice president. Both will continue to make their headquarters in New York.

● **M. L. (Jack) Cunningham** has recently joined the staff of Standco Brake Lining Company, 2701 Clinton Drive, Houston, Texas. He has had 19 years' experience as drilling and cementing engineer with Gulf Oil, Humble, Halliburton, Dowell, and others. C. W. Hanslip, president of Standco, has announced that Jack will coordinate Standco sales and service between supply houses, drilling contractors, and rigs. "Other duties of the job," Hanslip said, "include trouble-shooting and keeping in touch with new developments and problems in the field."

● **Thomas A. Printon,** vice president of National Oil Products Company, Harrison, New Jersey, has announced the appointment of **Miss Emily A. Taylor** as manager of the industrial advertising division.

● **E. H. Wellemeyer** has been elected vice president and director of the Cities Service Oil Company (Pennsylvania). Wellemeyer was previously assistant manager of the export department of Cities Service Refining Corporation. He joined the Cities Service organization in St. Rose, Louisiana, in 1923. From 1933 until 1940 he represented Cities Service on the Gulf Coast, became manager of its Gulf Coast Division in Houston in 1941, and held this position until he came to New York to the export department in 1943.

E. H. Wellemeyer

● **Dr. Everette L. DeGolyer,** Dallas, Texas, internationally known oil operator, geologist, and educator, has been elected a member of the board of directors of Southern Pacific Company. His election to that office was announced by President A. T. Mercier following a meeting of the board in San Francisco. Dr. DeGolyer, one of the most widely known men in the petroleum industry, is the first Texan to ever be elected to Southern Pacific's board of directors. He will fill the vacancy created by the death of Walter Douglas of New York and Phoenix, Arizona.

● **Dr. George M. Buffett** has been appointed technical director of the Pittsburgh Plate Glass Company's new paint plant at Springdale, Pennsylvania. Also appointed is **Wallace E. Shepard, Jr.,** who will serve as manager of industrial sales.

● **Robert E. Paxson,** newest member of the Taylor Instrument Companies' sales force, has just been established in the Midwest with headquarters in St. Louis, Missouri. Paxson had had considerable experience with instrument applications. He was employed previously as assistant chemist at Holly Sugar Company, Torrington, Wyoming, until 1937 when he was made chief chemist. He remained in that position until he left for the Navy as an ordnance reserve officer in 1943. Upon discharge from the Navy, he completed an 11 months' industrial training course at the Taylor Instrument Companies home office in Rochester before reporting to St. Louis.

● **John L. Abbott** recently joined North American Philips Company, Inc., New York, as application engineer in the Industrial X-ray Division. Abbott was born in Fairfield, Idaho, and graduated from the Colorado School of Mines in 1941. He was employed by Wright Aeronautical Corporation from 1941 to 1946 as senior metallurgist.

● **Dale L. Bennett** has been made midwestern zone manager of the Briggs Filtration Company, Bethesda, Maryland. Bennett, a graduate mechanical engineer and until recently actively engaged in various engineering capacities in the Chicago area over a 12-year period, will supervise the promotion of Briggs' line of industrial oil filters in his district from headquarters in Chicago.

● **Erling Klafstad,** who has been connected with Crosby Steam Gage and Valve Company for 18 years as chief engineer, has been elected a vice president, in charge of operations and engineering.

● **George C. Chatneuff** has been appointed district manager of the Houston, Texas, territory of the Bridgeport Brass Company, with office and warehouse at 2216 Walker Avenue, Houston 1, Texas, it was announced by Austin R. Zender, vice president in charge of sales. Prior to his promotion, Chatneuff was connected with Bridgeport's St. Louis office, serving the oil refinery industry in Oklahoma and in Kansas.

● **Donald P. Jones,** Swarthmore, Pennsylvania, has been elected assistant comptroller of Sun Oil Company. Jones fills a vacancy that has existed since 1944 when **Robert G. Dunlop** was elected comptroller.

● **R. L. Clifton,** Tulsa, manager of the production department for The Carter Oil Company, retired from active service March 1, after 29 years with the company. Clifton began his career with Carter in 1917 at Augusta, Kansas, as a district foreman. He played a major role both in development of Carter properties in the Seminole and Burbank fields and was in charge of production in the Oklahoma City field until 1936, when he transferred to the Tulsa office. **R. J. Sullivan** will continue as assistant manager of the department and **O. N. Knox,** Seminole, division superintendent for Carter in the Oklahoma-Kansas area, will be transferred to Tulsa as assistant general superintendent of the production department.

● **George W. Marshall, Jr.,** has been appointed general sales manager, Asbestos Products Division of Raybestos-Manhattan, Inc. In his new position, Marshall will continue as general manager of the Asbestos Textile and Packing Division and also will direct the sales activities of the Equipment Sales Division.

● **C. A. (Mugs) Mulligan,** well-known pipe-line specialist, announced that he is re-entering pipe-line work after an absence of several years. He had retired earlier due to his health. Mulligan is known for his work as general superintendent on construction of the Iraq pipe line in the early 30's. He formerly was with Humble Pipe Line Company, and his last connection before his retirement was with O. C. Whitaker Contracting Company. Mulligan is making his headquarters in Houston, Texas.

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Thermoid engineers have developed a complete line of braking materials to meet the special requirements of every kind of brake drum, every type of application. Thermoid friction materials include full molded blocks, woven blocks—metallic and non-metallic—countersunk and drilled. Woven material is also available in roll lots.

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ROTARY BRAKE BLOCKS • WOVEN OIL FIELD BRAKE LININGS • ROTARY HOSE SLUSH PUMP HOSE • FLEXIBLE DISCHARGE UNIT HOSE • HOSE OF ALL TYPES • V-BELTS AND DRIVES • OIL COUNTRY BELTING • STUFFING BOX RINGS • "NO WIP" LINE SAVERS • WIRE LINE TURN BACKS • PIN TYPE PIPE PROTECTORS • MOLDED PRODUCTS

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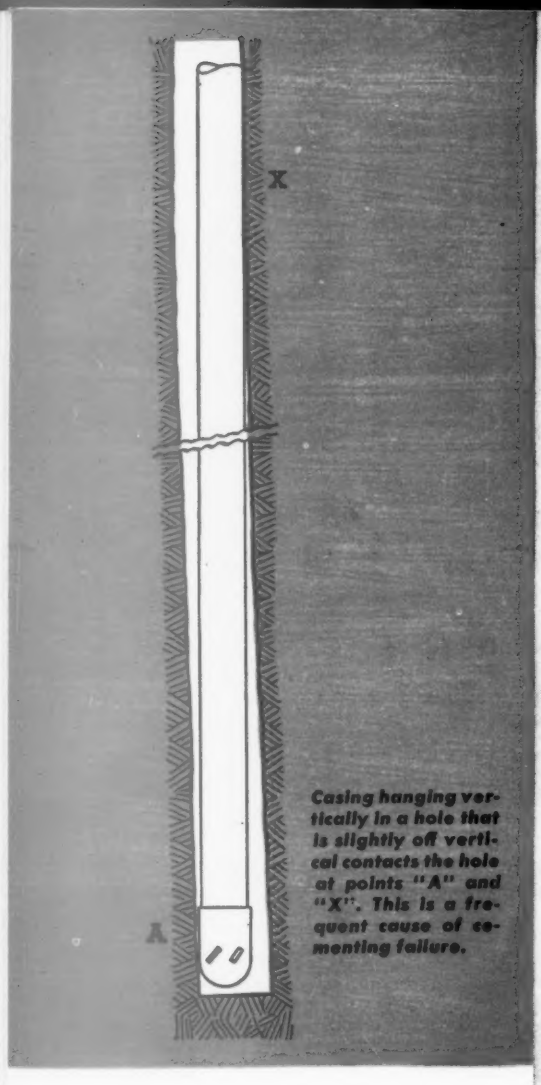
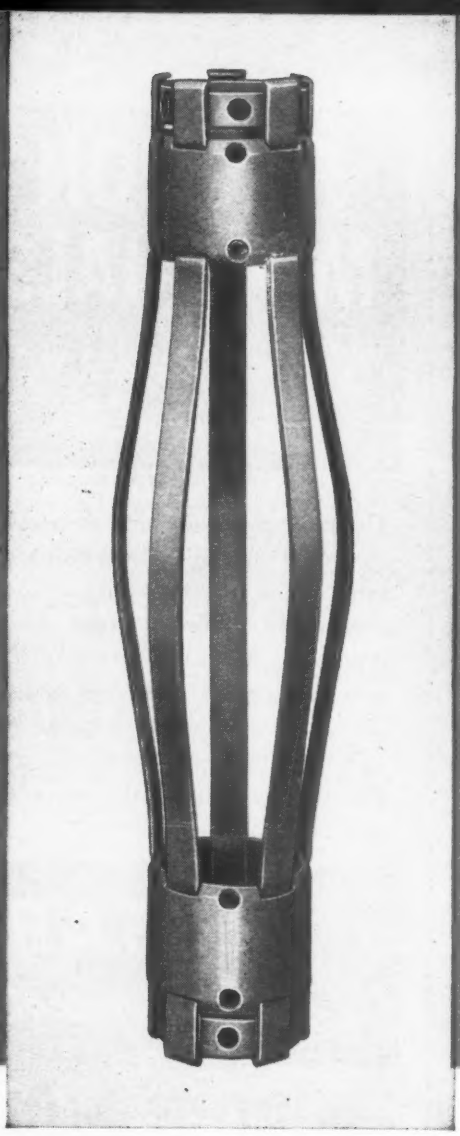
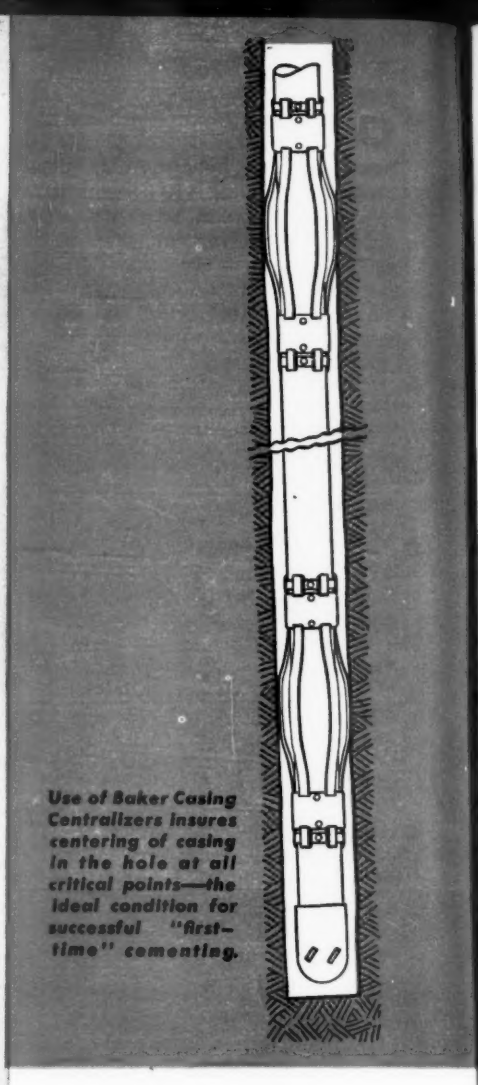


Casing hanging vertically in a hole that is slightly off vertical contacts the hole at points "A" and "X". This is a frequent cause of cementing failure.





Use of Baker Casing Centralizers insures centering of casing in the hole at all critical points—the ideal condition for successful "first-time" cementing.

IT PAYS TO CENTER CASING

When casing is off-center and leaning against the side of the hole at the shoe joint (left view above) the hazard of channeling is obvious. It is also easy to see why so many cementing jobs are failures because it is impossible to place a uniform body of cement ALL AROUND the casing at the vital shoe joint when the casing is not centered. So long as this condition exists, there are sure to be failures to secure good water shut-offs as well as other cementing failures.

Now let's study the drawing at right which illustrates how Baker Casing Centralizers (Product No. 910) provide a uniform annulus for placement of cement entirely around the casing at critical cementing points, and minimize the danger of channeling. Baker Casing Centralizers are simple and effective; they are easy to install and use; they are inexpensive and can be secured promptly through your nearest Baker office or representative.

BAKER
OIL TOOLS

It's Time to Center YOUR Casing!

If you would like a copy of the New BAKER Casing Centralizer Broadcast, which describes and illustrates many important applications, address Baker Oil Tools, Inc., Box 127, Vernon Station, Los Angeles 11, California.

BAKER OIL TOOLS, INC., LOS ANGELES • HOUSTON • NEW YORK

Man (entering grocery store): I want to get some shorts for my pigs. How much are they?

Girl Clerk: So you're another one of those wisecrackers, huh? I suppose you'll be wanting brassieres for your cows next!

* * *

The judge finished his lecture to the defendant in a divorce action saying: "I've decided to give your wife $40 a month."

"That's swell judge," said the ex-husband. "I'll try to slip her a couple of bucks now and then myself."

* * *

Joan says her boy friend is ambitious; has been since he was knee high.

* * *

Man: When will your dad be fit for work again?

Boy: Can't say for certain, but it will be a long time.

Man: What makes you think that?

Boy: 'Cause compensation's set in.

* * *

Wolf: A guy who always has girls running through his mind—they're afraid to walk!

* * *

Teacher: Give me a sentence containing a direct object.

Junior: Teacher, you are very beautiful.

Teacher: What's the object?

Junior: A good report card.

* * *

A customs officer, while examining a sailor's baggage, discovered a bottle of whiskey. "I thought you told me there were only night clothes in that suitcase?

"Right," replied the gob, "that's my night cap."

* * *

"My son doesn't want to get married."

"Yeah? Just wait until the wrong girl comes along."

* * *

"I just got out of prison this morning," a traveler told a man on the train. "It's going to be tough, facing old friends."

"I can sympathize with you," commiserated the other. "I'm just getting home from Congress."

* * *

Whenever a politician talks, no matter what he says, we're skeptical; and on those rare occasions when he's silent, we're highly suspicious.

* * *

Small boy: Mr. Jones, Dad wants to borrow your corkscrew.

"All right, sonny," said Jones, reaching for his coat, "You run along home—I'll bring it over."

"You look very downcast."

"Yes, my wife has been away for six weeks and I wrote her every week and said I spent the evenings at home."

"Well?"

"She is back now and the light bill has come in—it's for 50¢."

* * *

Where ya going, Zeke?

Town.

What's the matter with that wheelbarrow?

Broke.

Who broke it?

Hired man.

Same hired man who got your daughter in trouble last year?

Yup.

Clumsy, ain't he.

* * *

FOR WOMEN ONLY

Out of a thousand men, there will be nine hundred and ninety-nine who will read this. The other one will be blind.

* * *

Hubby returned home unexpectedly. A pair of shoes were on the floor. He went into a white fury. Picking them up, he looked at them, compared them with his own shoes, and then his anger subsided.

He put them down, great relief showing on his face. "For a minute I was ready to tear the house down," he explained. "I though the maid had forgot to put my shoes away, but I see these are not mine."

* * *

A stenographer defines a wolf as a modern dry cleaner. He works fast and leaves no ring.

* * *

"I have a husband who is rich,
He adds much to my life,
He buys me everything I want—
But please don't tell his wife!"

* * *

Mary: Would you care to learn love-making by mail?

Ruth: Well, that all depends on the male.

* * *

Teacher to history student: "You want to know why you didn't pass in your history test? Well, your answer to the question 'Why did the pioneers go into the wilderness' was interesting from the standpoint of sanitation, but it was still incorrect.

* * *

Conductor: How many in this berth?

Passenger: Just one. Here's our ticket."

* * *

Girl needs a job. Is willing to struggle if given opportunity.

STATE CAPITOL,
ALBANY, N. Y.

HIGHER EFFICIENCY WINS IN NEW YORK STATE

Cities, processing plants and manufacturing firms throughout the state of New York now own more than three hundred and twenty-five Layne high efficiency Well Water Systems. These individually designed, quality built and correctly installed water systems are now producing millions of gallons of water daily at an amazingly low cost.

Into all Layne Well Water Systems only the very finest quality materials have gone, thus providing the absolute maximum in long life with a minimum of upkeep cost.

Layne Well Water Systems and Vertical Turbine Pumps possess many distinctive and definitely superior features that have been developed and thoroughly proven by Layne. Engineers the world over readily recognize Layne Well Water Systems as being the best that money can buy.

For further information, catalogs, bulletins., etc., address LAYNE & BOWLER, INC., General Offices, Memphis 8, Tenn.

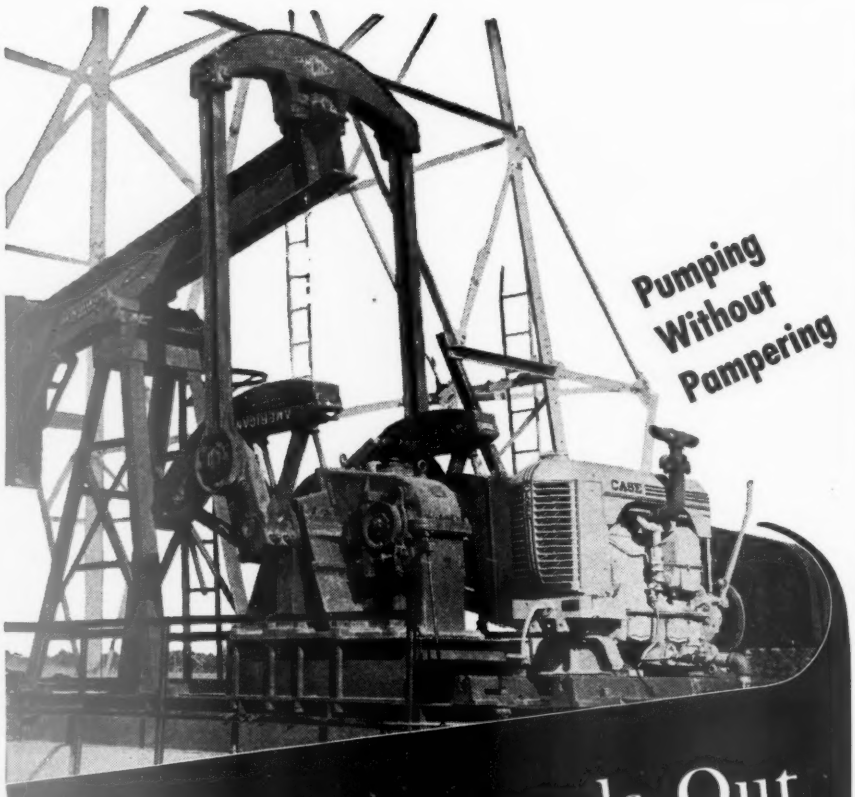
PUMPS For

Wells—Lakes—Rivers—Reservoirs—Irrigation Projects—are obtainable in sizes from 40 to 16,000 gallons per minute, powered by electric motor, V-belt or angle gear drives. Write for Pump Catalog.

LAYNE

WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Laye-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Wash. ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Western Co. of Minn., Minneapolis, M'nn. ★ International Water Supply Ltd., London, Ont., Can., ★ Layne-Hispano Americana, S. A., Mexico, D. F.



One Thing Stands Out *as Years Go By*

Main reason for the growing respect that oil men have for Case Oilfield Engines is ENDURANCE. Some Case engines have run non-stop for as much as two years. Endurance is why they regularly run months longer before major overhaul, why forced shut-downs are rare, why minor upkeep is really minor.

One secret of this endurance is the exceptional protection provided against destructive dust and dirt. Another is the lubricating system that works "for sure" in wide extremes of weather. Altogether, it comes from making every part a bit better than might seem necessary.

Shown above on a job in the East Texas Oilfield is the 42 H.P. Model "DE." Other Case Oilfield engines are the 28½ H.P. "SE" and the 61 H.P. "LAE." For full information, call the distributor who maintains service in your area. J. I. Case Co., Racine, Wis.

OIL-FIELD ENGINES

CASE

DISTRIBUTORS

Southwest Machinery Company
1900 Linwood Blvd., Oklahoma City; Tulsa and Hobart, Oklahoma

Wm. K. Holt Machinery Company
San Antonio, Texas

Southwest Equipment Company
Dallas and Kilgore, Texas

Goodman Bros., Inc.
Midland, Texas

Rockwell, Jr., president

At the annual meeting of Rockwell Manufacturing Company, Pittsburgh, Pennsylvania, the board of directors elected W. F. Rockwell Jr., president. Rockwell formerly served as vice president and general manager. Colonel Willard F. Rockwell, who has been both president and board chairman, will retain the office of chairman of the board. All other officers were re-elected.

W. F. Rockwell, Jr.

The directors voted a dividend of 10 cents a share on common stock payable March 5, 1947, to shareholders of record as of February 21, 1947.

Rademacher promoted

Young Radiator Company, Racine, Wisconsin, announces the appointment of Theodore C. Rademacher, Jr., advertising and sales promotions manager, effective March 3. Rademacher, a native of Racine, was formerly assistant merchandising manager of the Massey-Harris Company, farm machinery manufacturers of that city. Prior to that he was engaged in advertising and display work for two other Racine concerns.

T. C. Rademacher, Jr.

Horace Sanders promoted

The promotion of Horace Sanders to assistant Southwestern district manager for The Cooper-Bessemer Corporation, is announed by Stanley E. Johnson, vice president and director of sales.

Horace Sanders

Sanders, who has been associated with Cooper-Bessemer for nearly 20 years, is well known throughout the southwest territory, having been active in engine and compressor sales and engineering for the last 13 years.

He began his career as stenographer and warehouseman for the Bessemer Gas Engine Company, at Shreveport, Louisiana, in February, 1927, and was transferred to the Southwestern headquarters office in Dallas in 1931 after the company had been consolidated with the present Cooper-Bessemer Corporation. Since 1933, when he became a junior salesman, he has been successfully de-

voting his efforts to sales and administration activities.

Sanders is a member of the Texas Society of Professional Engineers, a past president of the Petroleum Engineers Club of Dallas, and a member of the Petroleum Engineers Club of Fort Worth.

In his new capacity, Sanders will assist A. A. Burrell, Southwestern district manager in the administration of Cooper-Bessemer sales and service.

Joins drilling firm

W. W. (Bill) Flenniken, former sales manager and director of advertising for the Halliburton Oil Well Cementing Company, resigned effective February 1 to join Fred M. Manning, Inc., of Denver as general manager of operations. The Manning organization, drilling contractor in the Rocky Mountain area, also has production in Kansas, Oklahoma, and Texas.

W. W. Flenniken

Flenniken goes to the Manning company with a thorough knowledge of oil production methods and management, having been actively engaged in this business for the last 13 years.

General sales manager

H. John Eastman, president of the Eastman Oil Well Survey Company, has announced the appointment of Ted W. Sess as general sales manager of the Eastman company. His duties will include the responsibilities of general sales supervision for the Pacific Coast, Gulf Coast, Mid-Continent, and Rocky Mountain divisions.

Ted W. Sess

Sess was formerly a sales executive of the Colorado Fuel and Iron Company and of its subsidiary, the Wickwire-Spencer Steel Company. He is a graduate of the Colorado School of Mines, where he received the degree of petroleum engineer. After several years of practical oilfield experience in the Mid-Continent, he spent six years in the sales department of Gates Rubber Company.

Pennsylvania meeting

The annual meeting of the Pennsylvania Grade Crude Oil Association will be held June 5 and 6 at the William Penn Hotel, Pittsburgh.

D. T. Ring of Columbus, Ohio, association president, voiced optimism regarding the production outlook of the Pennsylvania Grade crude oil region in 1947. He pointed out that each district in the region showed an uptrend in production last year over 1945.

W.P.R.A. expands

H. T. Ashton, president of the Western Petroleum Refiners Association, announces that the association is expanding its activities to include the field of industrial relations. This new department was established March 15.

This department will keep the members and the industry fully and promptly advised on current legislative matters, decisions, rules and regulations, and, in addition, all statistical information that is believed to be important and beneficial.

James T. Rasbury, Washington, D. C., has been appointed director of the industrial relations division. Rasbury graduated from Michigan State Normal College with an A.B. degree. He completed graduate work at the University of Oklahoma Law School and Washington University, and recently was admitted to the District of Columbia bar. His experience includes terms of service with the Studebaker Aviation Corporation and the Federal Bureau of Investigation. Mr. Rasbury was recently placed on the inactive list as a reserve officer.

Use Acme Cable Tools

Trustworthy Since 1900

Acme Drilling Bits "deliver" their own best sales talk under-ground: making more hole per dollar of bit-cost. And the driller's confidence is ever-sustained: by our policy of using only the finest bit steel and applying a brand of craftsmanship which makes QUALITY-FIRST its constant watchword.

(1st) All billets must meet Acme's rigid analysis specifications. A range of over 5-points (not the mill's usual 10) and a shipment is refused. This exactness cost us extra. But it simply means your EXTRA protection "down hole."

(2nd) Uniform, maximum toughness is assured by electrically controlled, automatic shut-off furnaces. Controlled temperatures, thus, insure: Proper Heat Treatment — Correct Forgings. . . . No "guess-work" creeps into any Acme Bit . . . anytime.

(3rd) The machining for perfectly balanced proportions and engineered tolerances isn't a matter of "stop-watch" timing. . . . If it takes extra time to turn a joint for a trouble-free fit, that's it. The finished Bit must be exactly RIGHT . . . for your trustworthy use.

In addition to featured Bit (Fig. 109) see color panel for other Acme Drilling Tools — for your more profitable use.

* * *

For more information, see our 24-page Catalog in Composite Catalog (Vol. 1). Or tell us your needs, by TODAY'S mail.

End View

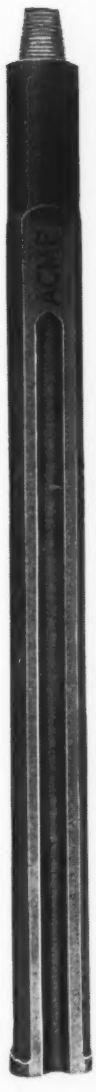
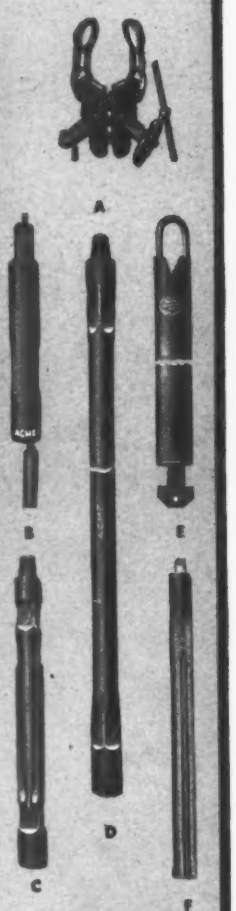


Fig. 109 Acme Drilling Bit

More of EVERYTHING You Need in an Acme String . . .



A—Wire Line Clamp, 12"
B—Prosser Swivel Socket
C—Drilling Jar
D—Drilling Stem
E—Bailer
F—Drilling Bit

Acme Fishing Tool Co.

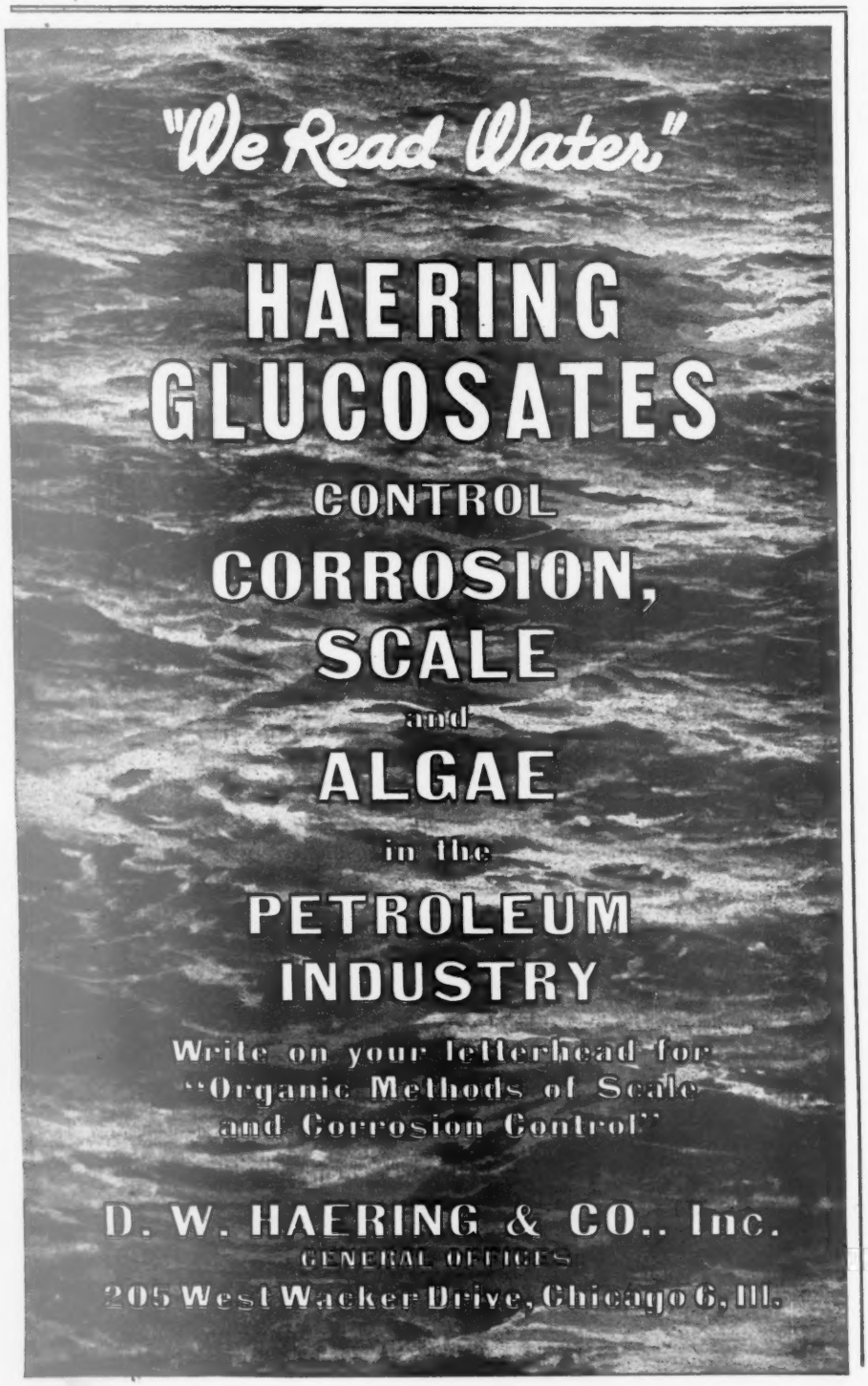
PARKERSBURG, W. VA.

Export Office: 19 Rector St., New York 6, N. Y.

Since 1900

Sales meeting Mid-Continent Supply

K. W. Davis, president of the Mid-Continent Supply Company, recently called into the general office more than 120 division managers, store managers, and salesmen to the company's first postwar sales meeting. The conference was held in Fort Worth, Texas, January 25-26, and was presided over by Frank John, assistant to Davis. Plans for the year were formulated and the company's new export setup was discussed.



To South America

Earl G. Ellis, export service manager of the Mid-Continent-Cummins Export Corporation of 42 Broadway, New York, left that port early in February for a three months' trip that will take him to all parts of Venezuela and Colombia in the interests of Cummins Diesel Engine Sales and Service. He will visit all active drilling areas and supply such service as might be required by the Cummins diesel engines operating there.

Earl G. Ellis

Los Angeles manager

R. H. Morse, Jr., vice president and general sales manager of Fairbanks, Morse and Company, Chicago, recently announced the appointment of John A. Cuneo as manager of the company's Los Angeles branch, succeeding Harry W. Brown who has retired.

Jack, as he is best known by his many friends and business associates, joined Fairbanks, Morse and Company in 1929 as a field engineer representing the company's export division, during which time he traveled the West Indies and in Latin America. He later was manager of the company's Havana, Cuba, branch.

Following his assignment in Cuba, he was transferred to the export division in New York. Later he joined the ranks of the scale division in Chicago and then became manager of the scale department of the company's St. Louis branch.

In recent years he has been assistant manager of the export division in New York and for the last two years was a member of the organizing staff of Fairbanks-Morse de Mexico in Mexico City.

McKISSICK

NEW! 60" Traveling Block
4 Sheave—200 Ton Capacity
5 Sheave—250 Ton Capacity

- Streamlined for balance, straight fall, safety.
- Sturdy, compact to assure maximum derrick working space.
- Large diameter center pin assures longer bearing life.
- Sheaves heat treated for maximum wear.
- Hy-load roller bearings with alemite lubrication.

Can be furnished with adapter which can be connected to drilling hook with short, rigid coupling.

Catalog on Request . . .

McKISSICK PRODUCTS CORPORATION

BOX 2496

TULSA, OKLAHOMA

IT'S THE FOOTAGE OF HOLE IN THE OIL SAND THAT COUNTS

YOU CAN'T DO THIS WITH AN OIL SAND

but...

You can drill drain holes

If you could actually *squeeze* the oil sands surrounding a well you could greatly increase recovery. The drilling of horizontal drain holes accomplishes a comparable result, insuring greatest ultimate recovery of oil as well as a more rapid and, consequently, more economical withdrawal.

The Zublin method of drilling horizontal drain holes is a very simple operation which may be applied either as a method of secondary recovery to increase production from "old" and partially depleted wells, or as a production technique in the completion of "new" wells.

Horizontal drain holes decrease water production. They reduce sand troubles. Uniform and controlled withdrawal of oil with less gas and less water from all areas surrounding the well becomes assured.

Interesting details and factual information regarding drain holes are included in our new Engineering Bulletin. Ask for a copy.

TURBINE BIT COMPANY

(Under the ownership of John A. Zublin)

2369 E. 51st St. (Phones: JE. 4433, JE. 6151) Los Angeles 11, Calif.

Zublin

HORIZONTAL WELL DRILLING

Sales engineer

Joseph C. Edler, until recently with the Atlas Imperial Diesel Engine Company, has been appointed sales engineer with the Superior Engine Division of The National Supply Company with headquarters in Chicago, according to an announcement by Robert M. Pearson, manager of sales. Edler will represent the company in its marine business on the Great Lakes, and industrial and stationary installations in the lake-bordering counties of Wisconsin and Illinois, the lower peninsula of Michigan, parts of Pennsylvania, New York, and Ohio. E. D. Cahill will continue to handle the river marine trade in the territory.

Joseph C. Edler

Joins Hammond Iron

Earl H. Bodinson has joined the sales staff of Hammond Iron Works of Warren, Pennsylvania, and Port Neches, Texas. He will make his headquarters in their New York offices at 630 Fifth Avenue, where he will assist R. E. Kramer, vice president in charge of sales.

Bodinson, a graduate of University of Illinois, has been identified with the metallurgical and sales side of the steel industry since 1928, with Illinois Steel Company, Jos. T. Ryerson Sons, Inc., and lately with the Pittsburgh Steel Company.

Earl H. Bodinson

Personnel changes

The untimely death of J. A. "Uncle Jake" Grubb, regional manager of the Kansas and Northwestern territories of Black, Sivalls and Byrson, Inc., has brought about three changes in the administrative personnel, according to A. J. Smith, president of the company.

Ed Nelson, who worked with Grubb for several years, has been transferred from the propane system sales force in Kansas City to Great Bend, Kansas, where he will direct the Kansas operations.

Ed Nelson

Marion Miller, who has been Grubb's assistant in the Wichita sales office, will be in charge of that office.

Lee Kelton will act as district manager in charge of the Connor Tank Divi-

sion in its operations in Wyoming and Colorado.

"Uncle Jake" Grubb was killed instantly in a motor car collision January 28. He had been with the company for many years and was widely known throughout the oilfield territory.

Schweinhard retires

George W. Schweinhard, vice president and general manager of Bethlehem Supply Company of California, retired February 28, after 25 years as active head of the company he founded. He is succeeded by Wendell M. Jones, who has been with the company since 1926.

Schweinhard, a native of San Francisco, started his own supply company for the oil industry, Petroleum Equipment Company, in 1922. His experience in this field dates back to 1912, when he was associated with the Kern Trad-

G. W. Schweinhard

W. M. Jones

ing and Oil Company in Coalinga. The only break in his long service in the oil industry came when he served in World War I. After coming out of the armed service, he worked for Lucey Manufacturing Company until he elected to start his own company. In 1945, Bethlehem Steel Company purchased the Petroleum Equipment Company, whose name was recently changed to Bethlehem Supply Company of California, now a subsidiary of Bethlehem Pacific Coast Steel Corporation.

Jones joined the Petroleum Equipment Company in 1926, after having served as chief engineer of the production department in California of The Texas Company.

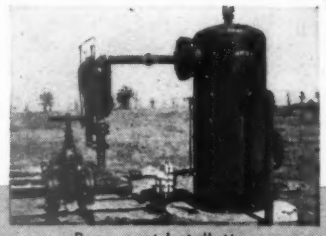
Export representative

Appointment of Roland E. Smith as exclusive export representative for Hi-Perm, an oil-well cleaning chemical, is announced by J. Paul Sievers, president, Atlas Production, Inc. Smith will handle all foreign sales of Hi-Perm, assisted by Knight C. Templeton, out of the company's office at 617 South Olive Street, Los Angeles, California.

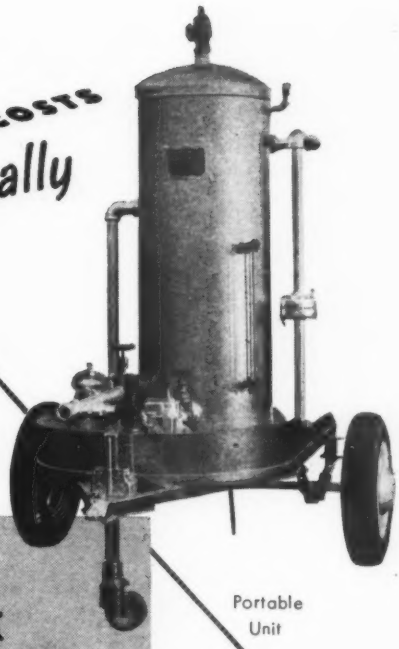
A trip of approximately four months' duration to all the oil producing countries of South and Central America is planned by Smith at the end of February. At this time he will introduce the chemical to their new market. Hi-Perm has been used successfully in treatment of newly completed wells, redrills, and old wells throughout California fields.

BOWSER

PORTACHEK CUTS PRODUCTION COSTS Automatically



Permanent Installation



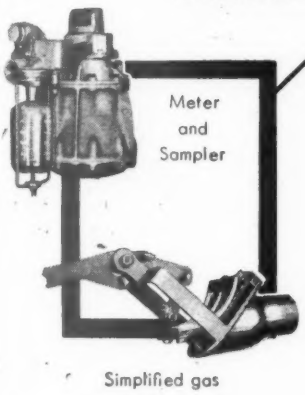
Portable Unit

Bowser Portachek

1 ELIMINATES GAUGE TANKS
2 STOPS EVAPORATION LOSSES
3 REDUCES PUMPING AND TRANSPORTATION COSTS
4 MINIMIZES FIRE HAZARDS
5 FURNISHES TRUE PROPORTIONAL SAMPLE
6 PROVIDES PERMANENT, INDISPUTABLE RECORDS
7 ACCURATELY RECORDS GROSS PRODUCTION
8 DETECTS SLEEPERS OR WET WELLS

PORTACHEK COMBINES THESE PROVED WELL-CHECK UNITS...

- Bowser Special Oil Well Xacto Meter
- Bowser True Proportional Sampler
- Bowser Spill-Proof Gas Trap with patented Peel-Off Valve—no packing glands—no valves to grind or adjust.



Meter and Sampler

Simplified gas and oil control valve (Patented)

BOWSER WELL-CHECK SYSTEMS ARE ENGINEERED TO HANDLE ANY TYPE OF OIL WELL PRODUCTION

Portachek provides an accurate, dependable method for checking the potential production of new wells before installing permanent equipment.

Write today for complete information on Bowser equipment for modern oil fields.

BOWSER, INC.
1329 CREIGHTON AVENUE, FORT WAYNE 2, INDIANA

Liquid Control Specialists Since 1885

A MERCOID
UNFAILING ADVANTAGE

Whatever your control requirements may be, it is conceded that the switch in a control warrants first consideration, due to its functional characteristics. All Mercoid Controls are equipped exclusively with hermetically sealed mercury switches of special design and selected materials.

Mercoid mercury switches are known the world over for their dependable service. They are not affected by dust, dirt or corrosion; nor are they subject to open arcing with its attendant consequences of pitting, sticking or oxidized contact surfaces, all of which, are likely to interfere with normal switch operation.

That is why among other things, Mercoid Controls on the whole give you assurance of better control performance and longer control life—a distinct and unfailing advantage—the reason why they are also the choice of America's leading engineers for many important industrial applications.

MERCOID CONTROLS are available in a variety of types for sensitive control of Pressure, Temperature and Lever actuation.

MERCOID
APPROVED CONTROLS

THE MERCOID CORPORATION
4201 BELMONT AVENUE • CHICAGO, ILLINOIS

Neilsen retires

The retirement of Karl P. Neilsen, founder of the Neilsen Pump Company at Long Beach, California, and promotion of R. K. Baker to manager of the organization have been announced.

Neilsen started the Neilsen company as a repair shop in 1924. It became the Neilsen Pump Division of the Oil Well Supply Company, subsidiary of the United States Steel Corporation, on August 1, 1945. Neilsen remained with the organization as division manager until his retirement. Baker has been associated with Neilsen in various capacities almost from the beginning of the Neilsen Pump Company in 1924.

E. E. Stevenson, chief engineer, and S. P. Glasgow, sales manager, continue in these capacities, Glasgow with added responsibilities in supervision of stores.

New firm

W. A. (Red) Davis announces the formation of the Davis-Lynch Sales and Engineering Company. The new company will serve as manufacturers' agents, handling the Superior oil and gas separator manufactured by Superior Tank and Construction Company, and representing the oil field division of Lebus Rotary Tool Works. In addition, the company will shortly announce a new line of float collars, float shoes, and guide shoes. Davis has had about 20 years' experience servicing floating equipment in the Gulf Coast area.

Present location of company is Katy and Post Oak Roads, Houston, Texas.

Personnel changes

Max M. "Lefty" Thomas has been appointed acting district manager by Lucey Products Corporation for the West Texas-New Mexico area, with headquarters at Odessa, Texas. He replaces J. M. Welsh, who resigned effective March 1.

C. F. Stringer has been named store manager of the Odessa branch.

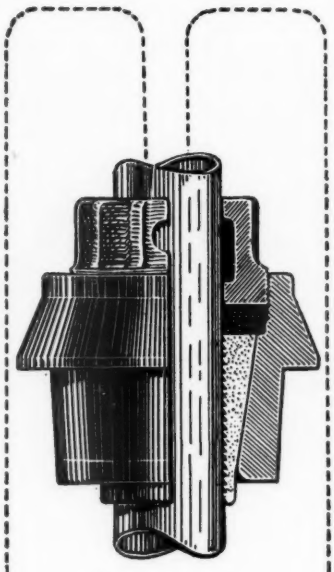
Thomas and Stringer will supervise operations of their area under the direction of Eric G. Schroeder, vice president, with offices at 600 Continental Building, Dallas.

Delbert M. Hadden replaces E. A. Lynch, resigned, as store manager of the Oklahoma City branch.

R. J. Macon has rejoined the Tulsa organization, with offices at 910 South Boston, working in conjunction with the treasury department.

Purchases factory

Acquisition of the J. P. Danielson Company factory in Jamestown, New York, for the manufacture of pliers, adjustable wrenches, and pipe wrenches, has been announced by the Plomb Tool Company, Los Angeles. The new plant provides additional tool manufacturing facilities in the East. Plomb's two plants in Los Angeles are now supplemented by factories in Chicago, Jamestown, and Portland, Ore.



TUBING HANGER
Fully Patented

PLAY SAFE
ASK FOR
HERCULES

Hercules Tubing Hanger insures absolute safety . . . eliminates the hazard of dropping tubing caused by pinched off collars, rigs burning or blowing down, or by other accidents. Hercules saves time . . . to repack you do not have to lift tubing, disconnect well or interfere with pumping operation. Packing is above slips, distorted by means of a screw-threaded nut. Hercules has few parts . . . is easy to install. Made to fit 4½" OD to 10¾" OD Berry Pattern Casing Heads and for 2", 2½" and 3" tubing.

Sold at all supply stores.

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TULSA, OKLAHOMA, Box 286
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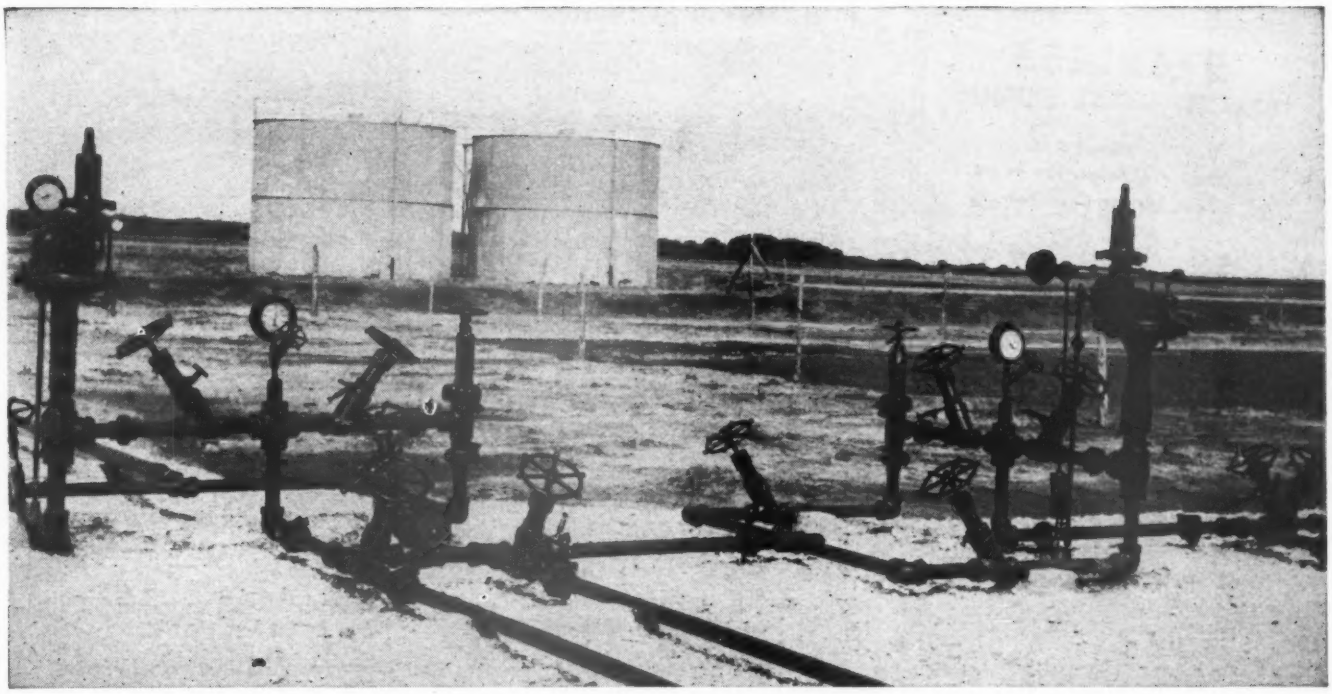

AUTOMATICALLY REDUCING . . .

4500 lb. Gas Well Pressure Down to 300 lb.

(Reducing stations for 2 Wells shown above)

These MECO Well Pressure Reducing Stations are assembled and tested as an integrated unit in our Houston Shop prior to shipment to you. Even with varying gas demand, the MASONEILAN Regulator FLOATS in a throttling position—NO CHART PAINTING at orifice meter; you can easily read and calculate flow from your chart. All equipment shown in photograph rated 6000 lb. Maximum Working Pressure. The MASONEILAN regulators, EDWARD valves, VOGT fittings, and NATIONAL pipe used are regular Houston Stock items with us.

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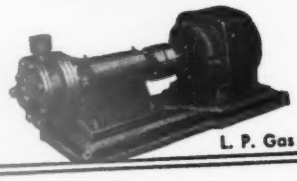
MECO

PEERLESS
CENTRIFUGAL PUMPS
(Formerly Dayton-Dowd)
Use This Handy Guide to Help You Select the Pump Your Service Requires


L. P. Gas Pump

PEERLESS PUMPS Listed below are but a few pumps in the complete line of Peerless Centrifugal Pumps. Bulletins available.

PUMP	G.P.M.	HEAD OR PRESS.
TYPE "A"	TO 60,000	UP TO 300 FT.

Applications: Designed for general service water pumping in a variety of industries. Embodies advanced construction for high-efficiency, low-cost operation.

TYPE "B"	TO 1,000	UP TO 700 LBS.

Applications: Designed particularly for medium capacity, high pressure boiler feed, oil refinery and pipe line service. Multi-stage, split case construction.

TYPE "AF"	TO 2,000	UP TO 125 LBS.

Applications: Peerless Fire Pumps (formerly Dayton-Dowd) are the foremost in fire pumps. Embodying latest developments, their selection assures low cost, modern plant fire protection. Underwriter's approved.

TYPE "CO"	TO 1,000	UP TO 200 LBS.

Applications: Especially developed for chemical, refinery, paper mill, food and process industries. Designed to handle acids, black liquors, hot oil, caustics, etc.

PEERLESS PUMP DIVISION
Food Machinery Corporation
Factories:
Canton 6, Ohio — Quincy, Ill.
Los Angeles 31, Calif.
District Offices:
Canton 2, Ohio; Ardmore, Pa.; Decatur, Ga.; Dallas 1, Texas
Distributors in Principal Cities

F. A. Marsh promoted

F. A. Marsh

Forrest A. Marsh, for eight years National Tube Company's division sales manager at Houston, Texas, has been appointed assistant to the vice president in charge of sales for the company. The appointment was announced by W. F. McConnor, vice president in charge of sales of this U. S. Steel pipe-making subsidiary. Marsh succeeds James B. Graham, who is retiring.

Marsh is a native of Culver, Indiana, and attended Purdue University. He joined National Tube as a machinist's helper at Gary, Indiana, in 1924, and held various mill positions until five years later, when he was appointed field engineer. He became a division sales manager at Houston in 1936, and has been manager of the company's sales office there since 1944.

Petro-Tech Service

Russell Keener and Keith Miner, former Lane-Wells Company employes, have organized Petro-Tech Service Company to provide gun perforating and allied services to operators in the Western Venezuela oil fields. They will also represent several oil tool manufacturers. Keener, former purchasing agent, and Miner, formerly California division sales manager and prior to that California operating superintendent, will maintain headquarters in Maracaibo. Petro-Tech Service Company has purchased two Lane-Wells gun perforating units.

Wins safety award

For the second straight year, The Fluor Corporation, Ltd., has been awarded second place for safety in the heavy construction division of the Accident Prevention Contest sponsored annually by the Associated General Contractors of America.

This award was made at the national convention of the association, which was held recently in Chicago. In compiling this outstanding safety record, The Fluor Corporation had a 2.10 severity rate for 4,065,864 man-hours of exposure.

Chicago manager

Roland E. Nelson has been appointed manager of the Chicago office of the H. K. Porter Company, Inc.

Nelson, who succeeds Geo. L. Green, was associated with the J. P. Devine Manufacturing Company for several years in an engineering capacity prior to its acquisition by the Porter organization, and was later transferred to Pittsburgh where he had charge of process engineering. For the last year, Nelson has been sales engineer serving the St. Louis territory.

GET ACCURATE RESULTS
Quickly . . Easily . . with
CURTIN CENTRIFUGES

No. 3480. 100 c. c. machine. Cranks and heads interchangeable with 15 c. c. machines.

You can maintain your required speed for the period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

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DEP'T. "C"
HOUSTON, TEXAS . . . NEW ORLEANS, LA.

"Best Bet Yet"
SAVE YOUR TUBING!

Tubing collars worn by contact with casing steal the profit out of pumping. Patterson-Ballagh Plastic Tubing Protectors prevent both collar and casing wear. Oil-proof, wear-resistant, insulating. They are pressed onto the collar under pressure and will not come off. Made in all sizes. End your tubing troubles. CALL in your Patterson-Ballagh man.

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PATTERSON-BALLAGH
A DIVISION OF BYRON JACKSON CO.
PLASTIC TUBING PROTECTORS

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N.A.C.E. meeting

The tentative program for the annual all-corrosion conference and exhibition of the National Association of Corrosion Engineers, scheduled during the four-day period from April 7 through 10, in Chicago has been drawn up. This year, for the first time, the entire proceedings of the association, together with the exhibition, will be held under one roof, at the Palmer House.

Eight technical sessions and 32 technical papers will be presented during the conference. Two symposiums will be held each morning, starting at 9:00 a. m., except Wednesday, when two sessions are also scheduled during the afternoon, starting at 2:00 p. m.

The meeting will get under way Monday, with registration set at 9:00 a. m., and the formal opening of the Exhibition Hall at 10:00 a. m. In the afternoon, the general assembly will be called to order at 2:00 p. m. by F. J. McElhatton, president of NACE. A general business meeting for members will be at 4:00 p. m.

Tuesday morning, four papers will be presented, dealing with corrosion problems in the water industry. Concurrently, listeners at the chemical industry symposium will be apprised of the latest developments and findings in the chemical field.

Wednesday morning, four papers will be presented during the oil industry session. At the same time, papers will be presented in another section of the hotel having to do with communications. In the afternoon, the electrical industry and gas industry symposiums will be held. Wednesday evening, the annual banquet of NACE will be held in the main ballroom of the Palmer House, at which time F. J. McElhatton, retiring president of NACE, will introduce the new officers.

During the final day of the conference, technical sessions will include papers on the problems confronted in general industry, as well as a symposium on cathodic protection.

Holds power show

A complete exhibit of all types of power and equipment for earth-moving and construction was reviewed on February 12, 1947, by 400 industrial equipment distributors and 200 others at the Melrose Park headquarters of International Harvester's industrial power division. The show was unusual in that 32 other manufacturers had machines on display in addition to International's complete line of crawler tractors, industrial wheel tractors, and diesel and gasoline engines. All this equipment consisted of machines mounted on International crawler or wheel type tractors or self-powered equipment built by manufacturers using International power.

Reminiscent of the great automobile shows held in Chicago before the war, the exhibit provided the most complete picture of industrial equipment ever presented, in the opinion of company officials. The show occupied a 40,000 sq ft section of the Melrose Park plant.

AIR COOLED
BURNER HEADS

ANCHOR
GAS BURNER

ANY B-3
BURNED OUT
HEAD REPLACED WITHOUT COST

MAXIMUM EFFICIENCY
LOWEST COST

You can reduce boiler maintenance permanently with Air Cooled Anchor Gas Burners. Yes, they are sold under a positive guarantee of satisfaction, with free replacement of any head that ever burns out.

Check the design here. You will find that Anchor Burner heads have two air port openings which allow air to pass through, keeping the burner head cool at all times. No fire brick required . . . no banking around the boiler necessary.

Anchor Gas Burners are designed with fewer parts for lower maintenance. Actual meter tests have proved its economy. Reduce your boiler maintenance permanently. Install Anchor Low Pressure Gas Burners. Buy the best . . . always buy WECO Products.

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PRODUCTS

WELL EQUIPMENT MFG. CORP.
Subsidiary of Chiksan Company
Houston 1, Texas
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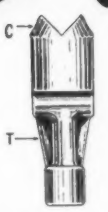
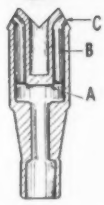
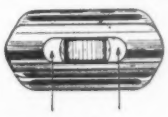
CHIKSAN EXPORT CO.
New York 7 Brea, Calif. Houston 1



"C" gas port. This roomy, protected opening is difficult to clog or foul, assuring an ample supply of fuel and an even steady flame. "T" The reenforced throat provides abundant strength where needed.



How it works. The gas and primary air strike the baffle or breaker plate "A", and are thoroughly mixed in the Chamber "B", before reaching the point of combustion "C".



Top view showing the twin vents in the air cooled head. Scale, rust, dirt, etc., from the boiler fall through harmlessly, while secondary air, a definite aid to efficient combustion, rises easily and positively through the openings.

WECO
Manufacturers and Distributors of Oilfield, Refining, Marine and Industrial Equipment

Sales meeting Continental Supply Company

The Continental Supply Company conducted a two-day sales meeting of Oklahoma-Kansas district key personnel recently at the Mayo Hotel, Tulsa. With Ross A. Brewer, district manager, in charge, the forty-six district men were addressed by F. I. Brinegar, executive vice president, J. A. Mussler, manager of tubular sales, and J. A. Davis, manager pipe line equipment division, all of Dallas.

Instrument conference

In connection with the Second National Instrument Conference in Chicago, September 8 to 12, the Instrument Society of America will have an exhibit.

The exhibitors at the 1946 "Show" had a 30-day option on the space in the Stevens Hotel Exhibition Hall. The general sale of exhibit space was announced on February 1. Information on reservations can be obtained from T. W. Robinson, chairman of the Exhibit Committee, 236 North Clark Street, Chicago 1, Illinois.

The national chairman of the conference committee is A. F. Sperry, Hubbard Engineering Company, Chicago. Chairman of Chicago committee, Hugh Ferguson, People's Gas, Light and Coke Company.

Fortify and Improve

YOUR OIL with

MALMSTROM WOOL WAX (LANOLIN)

- **GREATER ADHESION** because it clings to surfaces better, thereby assuring improved protective coatings that effectively retard rust and corrosion. Exceptional clinging and tackiness made it ideal for protecting ordnance during the war.
- **A NATURAL WAX,** absolutely free from glycerides.
- **EASILY SULPHURIZED and PHOSPHORIZED** for lubrication additives.
- **HIGH FLASH and FIRE POINT.**
- **EASILY CONVERTED INTO WATER INSOLUBLE SOAPS FOR GREASE COMPOUNDING.**

Let us tell you how to use MALMSTROM WOOL WAX (Lanolin) to fortify and improve your oil. Samples and prices upon request.

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America's Largest Processor of Wool Fat and Lanolin

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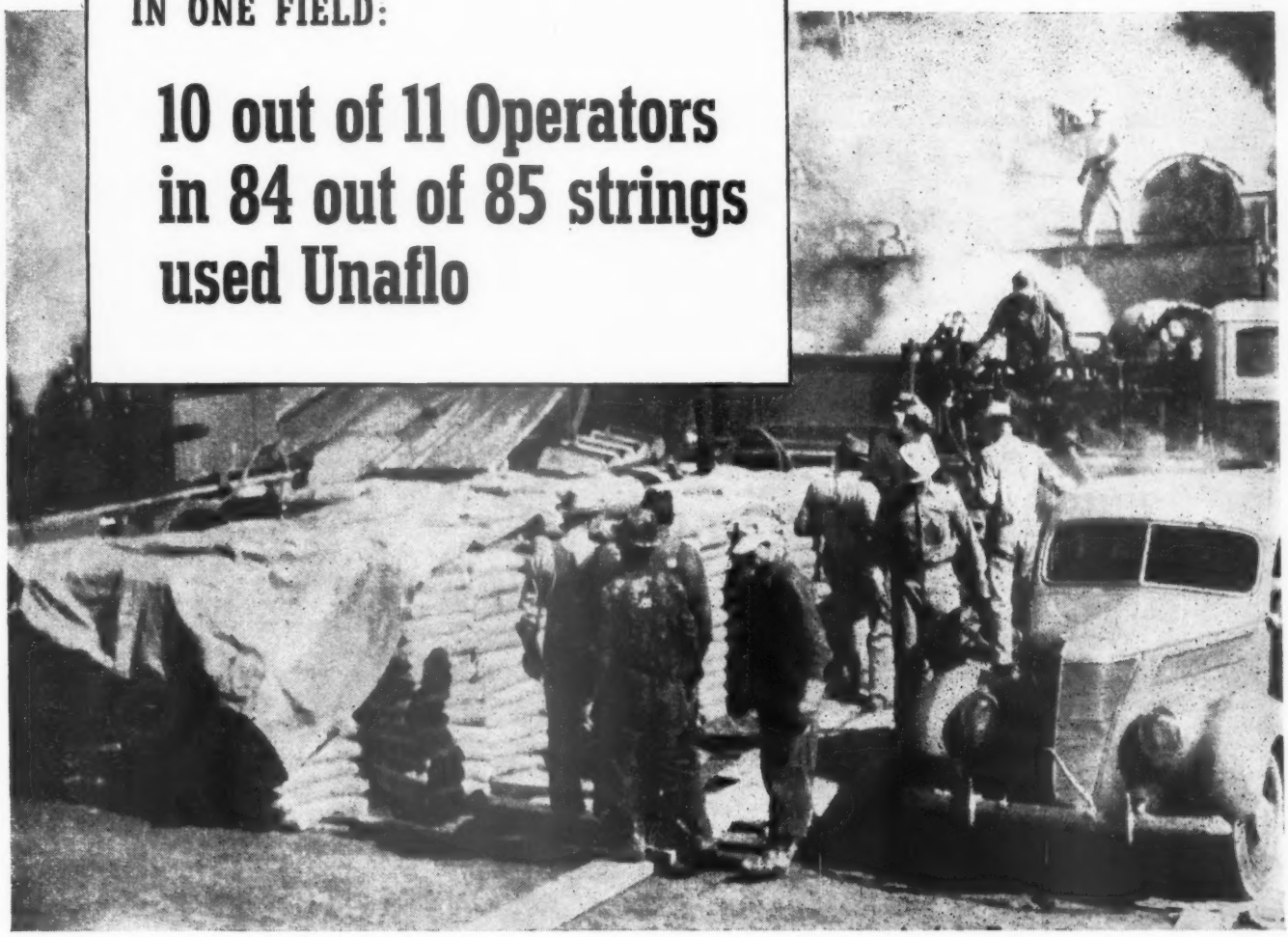
IN ONE FIELD:

10 out of 11 Operators in 84 out of 85 strings used Unaflo



- **Temperatures averaged 150°F.**
- **Pressures never much below 3,600 psi.**
- **Strings averaged 8,500 ft. of 5½" casing.**

The operators in this field didn't gamble with trouble . . . they chose Unaflo oil-well cement.

Because of its *retarded* set, Unaflo does not stiffen prematurely when exposed to heat and pressure or when subjected to unforeseen delays. It remains fluid and pumpable during the cementing operation and then sets to a hard, impermeable seal.

PE-U-76

Send for "Unaflo Oil-Well Tables," a shirt-pocket booklet of down-the-well volumes of cement and mud. Write to Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Amicable Building, Waco; Kansas City; Birmingham; Chicago; New York. Export Distributors, United States Steel Export Company, New York.

- **Unaflo *Retarded* Oil-Well Cement**
  Resistant to Sulfate Waters
- **Atlas Portland Cement—Type I**
- **Atlas Portland Cement—Type II**
  Resistant to Sulfate Waters
- **Atlas High-Early Cement—Type III**

UNIVERSAL ATLAS CEMENT COMPANY

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel—Sunday Evenings—ABC Network*

FORGED STEEL UNIONS

Your Most Dependable Servants

Petro UNION

America's most universally used Union! A partial list of proven services: Pressures from a vacuum to 3000 lbs. Temperatures from 100° below zero F. to 1000° above zero F. Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and all service in which Steel or Wrought Iron Pipe is used. Made to A.A.R. Standards and priced in line with 300 lb. A.A.R. Malleable Iron Unions.

Write for Pamphlet AM-67

SIZES
⅛" to 3"

Socket Weld UNION

This is our "PETRO UNION" with the end pieces reamed to U.S. Navy Specification B-173 for socket welding. Ends squared to facilitate welding. It has permanently lubricated nut threads and machined and cold rolled steel seats.

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SIZES
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Handle-Bar UNION

4000 AND 6000 TEST

4000 Test: Sizes ⅜" to 1½" V-thread in nut.

4000 and 6000 Test: Sizes 2" to 4" modified Acme Threads in nut.

Steel to steel, or bronze to bronze cold rolled seats. Permanently lubricated nut threads. To tighten, or loosen the nut, USE A HAMMER INSTEAD OF A WRENCH.

Write for pamphlet 4P-HB.

SIZES
⅜" to 4"

ORDER BY TRADE NAME FROM YOUR JOBBER

ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

Lone Star promotions

D. A. Hulcy, president of Lone Star Gas Company, Dallas, Texas, has announced the appointment of L. T. Potter to the newly created position of asistant to the president. Potter has been superintendent of production and assistant general superintendent of the transmission division of the company. He has been with Lone Star a little more than 18 years.

L. T. Potter

In his new position Potter will assist the president in duties affecting all branches of the company. Potter is a graduate of Texas A. & M. College. He was transferred from field work in 1931 to Lone Star's Dallas office, and was appointed assistant production engineer. He was promoted to chief production engineer in 1939, and to production superintendent in 1941. In 1945 he was assigned additional duties of assistant general superintendent of Lone Star, under Julian L. Foster, general superintendent.

Simultaneously with the announcement of Potter's promotion, Elmer F. Schmidt, vice president of the company in charge of the transmission division, announced the following changes in personnel in that division:

Thomas S. Bacon to be promoted from research engineer to chief engineer; Richard A. Minter to be promoted from office engineer to assistant chief engineer; Edgar Allen Brown to be promoted from chief production engineer to superintendent of production.

A.I.M.E. Juniors meet

At the Rio Hondo Country Club, Downey, California, on February 13, a sizable gathering of AIME Juniors, Pacific Petroleum Section, and their guests, held an interesting symposium on gun perforation. With three authorities leading the discussion, all phases of the subject were aired, including ballistics, design of gun and firing chamber, penetration and bullet size, powder charge, effect on casing, cement, and formation, and removal of burrs. The speakers were Val E. Forsythe, Lane-Wells Company, O. N. Andrew, Byron-Jackson Company, and W. C. "Hut" Erwin, McCullough Tool Company.

G-E appointments

Four promotions in the compound and plastics division organization of the General Electric chemical department are announced. John L. McMurphy, manager of the compound division, named H. Arthur Howe superintendent, Clarence H. Slayton, Jr., engineering manager, and J. Rae Stirrat sales manager for the compound division, and George P. Lehmann manager of the plastic division, appointed Nathan A. Freuden as division sales manager.

Heads new post

J. H. Jewell, manager of the industry sales departments of the Westinghouse Electric Corporation, recently announced the appointment of C. B. Stainback as industrial syndicate manager, a new position created to better coordinate the industrial sales activities of the company.

Stainback, who was manager of the industrial sales department, has been with Westinghouse since 1910, the same year he was graduated from North Carolina State College. During practically his entire business career he has been associated with sales activities in the electrification of industry. The broad understanding of industrial electrification problems he gained during nearly 37 years of service resulted in his selection for the new position.

John E. Payne has been made headquarters sales manager. Payne, who was formerly manager of industrial sales for the central district, succeeds C. B. Stainback.

Compact meeting

Spring quarterly meeting of the Interstate Oil Compact Commission will be held in Birmingham, Alabama, on April 24, 25, and 26, Hiram M. Dow, commission chairman, has announced.

Program of special interest to the southeastern oil and gas producing states is being planned.

Committee studies authorized at the December compact meeting in Dallas, Texas, are under way and it is expected that they will be completed in time for the Birmingham meeting.

The April meeting will be the first to be held in Alabama, which became a member of the Interstate Compact Commission in 1945.

H. R. Shidel dies

H. R. Shidel, 53, manager of the Dresser Manufacturing Division's Houston warehouse, died February 28, at Houston, Texas, following a heart attack.

Born in Wisconsin, he attended the University of Utah. During all of his working years, he has been engaged in selling activities in the oil industry.

Before joining the Dresser Manufacturing Division, Bradford, Pennsylvania, in March, 1937, Shidel was with the Eagle Picher Lead Company, at Cincinnati, Ohio.

Establishes fellowship

The Texas Company is establishing an industrial fellowship at Purdue University for study of mass transfer and heat transfer in refining and chemical processes, Dr. G. Stanley Meikle, director of Purdue's Research Foundation has revealed.

The fellowship results from the growing importance of processes in which reactants in the gas phase are contacted with a solid catalyst and the need for basic data necessary for the design of equipment for these processes.

This rugged Skid-Mounted Core Drill, manufactured by Hoard Exploration Company of Texas, is a typical example of the type jobs Wisconsin Air-Cooled Engines perform. The Core-Drill is built on skids especially for adaptability to swamp lands . . . but, can be mounted on a jeep for use on dry land equally as well. The Model VE4 Wisconsin 4-cylinder Air-Cooled Engine powering the Core Drill is built for heavy-duty serviceability. It is equipped with Timken tapered roller bearings at both ends of the crankshaft to assure fullest protection against bearing failure under continuous, full-load operation and to take up end thrust . . . For real efficiency in oil field service and operating economy look for the equipment powered by Wisconsin Heavy-Duty Air-Cooled Engines.

WISCONSIN MOTOR
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MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
510 Atlas Building, Tulsa, Oklahoma
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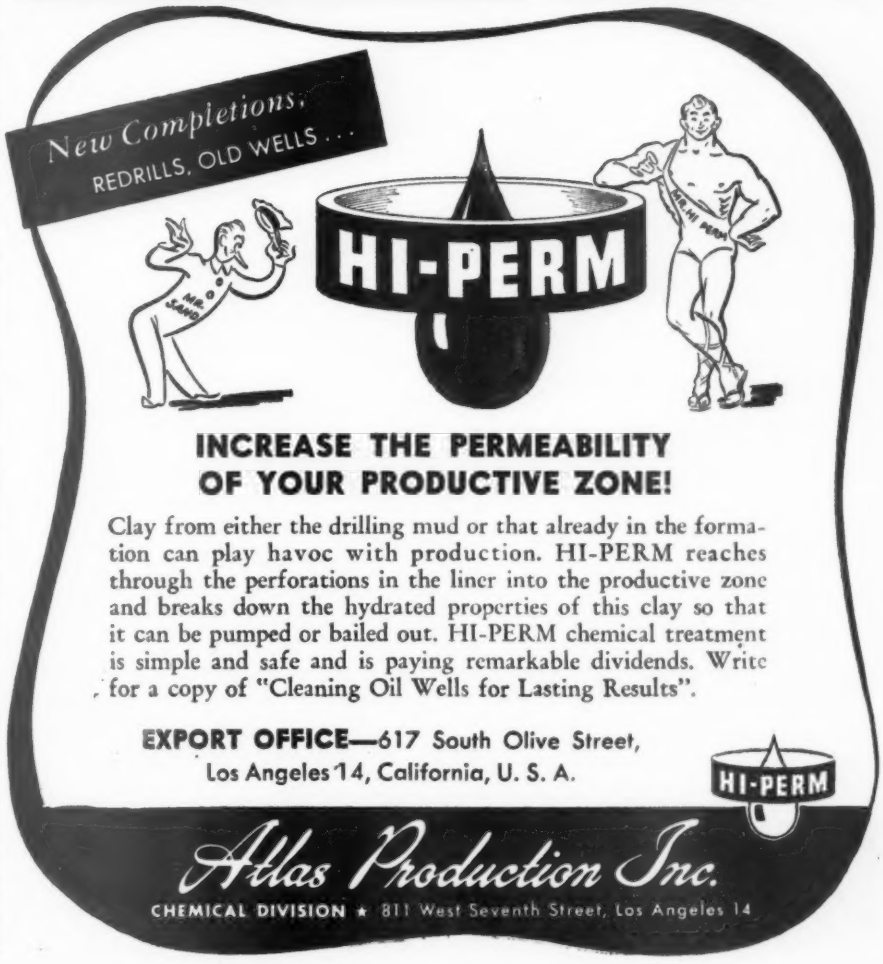
Oil field distributors for Wisconsin Engines and all types of utility units.



INCREASE THE PERMEABILITY OF YOUR PRODUCTIVE ZONE!

Clay from either the drilling mud or that already in the formation can play havoc with production. HI-PERM reaches through the perforations in the liner into the productive zone and breaks down the hydrated properties of this clay so that it can be pumped or bailed out. HI-PERM chemical treatment is simple and safe and is paying remarkable dividends. Write for a copy of "Cleaning Oil Wells for Lasting Results".

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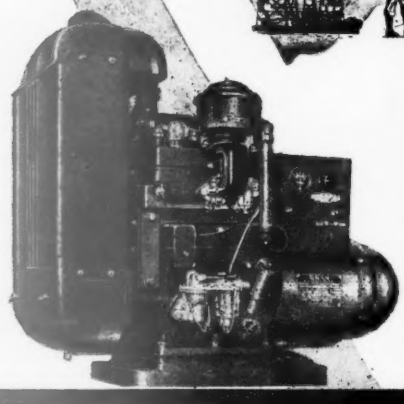
CHEMICAL DIVISION ★ 811 West Seventh Street, Los Angeles 14

Onan PRODUCTS

electricity

. . . . for every oil field job!

Lighting Survey Power Tools Pumps



There's an Onan Electric Plant to meet the requirements of any oil field application—to give long, full-capacity service under the severest operating conditions.

Lightweight one or two-cylinder heavy-duty, air-cooled models for maximum portability. Onan two, four and six-cylinder water-cooled plants for continuous operation, stationary or mobile.

ONAN ELECTRIC PLANTS—A.C.—350 to 35,000 watts in standard voltages and frequencies; D.C.—600 to 10,000 watts, 115 and 230 volts. Battery chargers—500 to 6,000 watts, 6 to 115 volts. ONAN AIR-COOLED ENGINES—CK: 2-cylinder opposed, 10 h.p.; BH: 2-cylinder opposed, 5.5 h.p.; 18: 1-cylinder, 2.5 h.p.

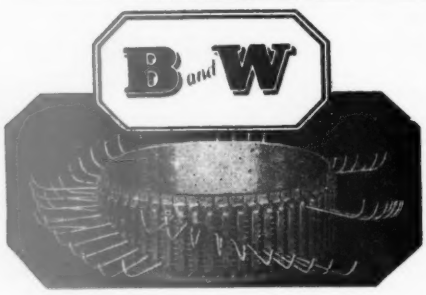
WRITE FOR SPECIAL FOLDER

D. W. ONAN & SONS INC.

2753 Royalston Ave. Minneapolis 5, Minn.

ONAN ELECTRIC PLANTS

B and W



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Enough B & W Wall Cleaning Guides to give you a good cement job cost only 1/10th as much as any squeeze job.

DON'T SQUEEZE!

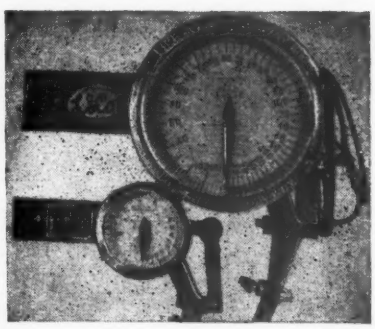
It Can Be Avoided.

BRUCE BARKIS — B and W INCORPORATED — KENNETH WRIGHT

Well Completion Specialists

HOUSTON, TEXAS • LONG BEACH, CALIF.

LINE SCALES



(Above) Super 500,000-lb. capacity, 14" dial. (Below) Packer Special, Capacity 40,000 lbs., 6" dial. 18 other models for every drilling, well servicing, or work-over need.

20 MODELS to choose from

With a LINE SCALE you know the pull on the line, and the weight on the bit in pounds. Repeated tests prove the accuracy and dependability of LINE SCALE readings under all working conditions . . . even in areas of rapid temperature changes.

LINE SCALE CO., Inc.

Box 4245 **Oklahoma City** Phone 6-1765

Gulf Coast Representative: Hiram Wheeler Box 8043, Houston 4, Texas—J2-1107

Reorganization

Two promotions, as well as a reorganization of his department, have been announced by M. S. App, vice president and director of production of General Petroleum Corporation. The promotions involve B. H. Robinson who has been assistant manager of production and is now promoted to manager of joint interest operations, and R. O. Swayze who has been promoted from his former job of assistant manager of the Rocky Mountain district in Wyoming to manager of the company's California drilling and production operations.

Both assignments are to newly created positions.

Robinson, who lives at 819 East Philadelphia Street, Whittier, California, is a native of Arizona and was educated at

R. O. Swayze

B. H. Robinson

the University of New Mexico and the United States Naval Academy. He joined General Petroleum as a timekeeper in 1925 and has advanced through various positions in acounting and production work to his new appointment, which became effective February 16.

Swayze's service dates from May, 1921, when he was employed as a clerk in Taft. Later he entered the geological department and in 1935 was appointed its assistant manager. Subsequently he was transferred to General Petroleum operations in Wyoming where he has been assistant manager up to the time of taking over his new duties. Swayze is a native of Pomona, Kansas, attended the Missouri School of Mines and Baker University.

Change of name

Engineering Controls, Inc. is the new corporate name of the firm of manufacturing, designing, and consulting engineers who, for many years, have operated internationally under the name Pacific Enterprise Products Company. Lloyd C. Harbert, formerly vice president and general manager, is now president of the new corporation. William G. Corey, well known consulting engineer of Los Angeles, is vice president in charge of engineering, and Forrest W. Monroe of Forrest Monroe and Associates, income tax consultants, is secretary and treasurer.

Included in the reorganization are plans for greatly expanded plant facilities and enlarged engineering personnel. Main offices continue at 2833 East 11th Street, Los Angeles 23, California.

Senior research engineer

Arthur McCutchan has been appointed senior research engineer of the product engineering and research department of Tube Turns (Inc.), Louisville, Kentucky, it is announced by J. D. Mattimore, the department's director and chief engineer.

Arthur McCutchan

McCutchan will be associated with A. R. C. Markl, chief research engineer, formerly mechanical engineer in charge of the pressure equipment and materials division of the M. W. Kellogg Company; Mason S. Noyes, research engineer, formerly senior marine engineer, Bureau of Ships, USN, and Henry H. George, research engineer, formerly a physicist in the Jones and Laughlin research laboratory.

New partnership

Willis G. Meyer and Leo A. Achtschin have formed a new partnership, Meyer and Achtschin, with offices in the Continental Building, Dallas, Texas. The firm will offer consulting and evaluation service in petroleum geology and economics.

Willis G. Meyer

Meyer is president of the Dallas Geological Society and a graduate of the University of Nebraska. He received advanced degrees from University of Cincinnati, and served as a geologist for Amerada Petroleum Corporation at Houston, Texas, and Shawnee, Oklahoma, from 1934 to 1938. From that time until February 1, 1947, he was associated with the firm of DeGolyer and MacNaughton, Dallas, and was a partner in the firm from 1942.

Achtschin is a graduate of the University of Detroit, receiving his degree in finance. He worked for the Society for Savings from 1934 to 1945, and was assistant to the vice president in charge of oil loans when he took a leave of absence to become a partner with the firm of DeGolyer and MacNaughton in 1942. He is also leaving the firm to form the new partnership.

Joins Kellogg company

Further impetus to the broadening development program of The M. W. Kellogg Company, of Jersey City, New Jersey and New York, New York, was seen in the announcement by H. R. Austin, president, that Brig. Gen. James Creel Marshall had been retained on the engineering staff of that company.

J. C. Marshall

Widely known in engineering and construction circles through his 30 years of service on many major projects in peace and war, Gen. Marshall will apply a lifetime of technical knowledge and experience to the broad range of new engineering and research projects included in the immediate program of The M. W. Kellogg Company. He assumed his new duties March 3.

Foremost among General Marshall's more recent army activities was his service on the atom bomb project. In June, 1942, he was directed to form the organization that in August of that year became the Manhattan Engineer District, charged with the development of the atom bomb. A year and half later he was on duty with troops in the Southwest Pacific area, serving in Australia, New Guinea, and the Philippines. During the latter half of 1945 he commanded the Boston Port of Embarkation and in 1946 was made president of the Engineer Board, the research and development agency for the Corps of Engineers, stationed at Ft. Belvoir, Virginia. Outstanding among the many diverse activities during the peacetime years, was his work as area engineer at Albany, New York, in charge of the $27,000,000 improvement project on the N. Y. State Barge Canal in 1935.

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Patton to South America

W. R. Patton

A. G. Evans-Lombe, vice president in charge of sales of The Parkersburg Rig and Reel Company, has announced the appointment of W. R. Patton to serve as sales and service engineer in South America. He will sail from New York some time in March for Venezuela and will spend several months in the oil fields of Colombia and Venezuela, after which he will establish permanent headquarters in Caracas.

Prior to assuming his new position as sales and service engineer he served as field engineer in Parkersburg's division office in Houston.

Joins advertising agency

H. N. Baum

Harry Neal Baum, advertising manager of Fairbanks, Morse and Company for more than ten years, has joined Gebhardt and Brockson, advertising agency, Chicago. Baum has an intimate acquaintance with the production, refining, and marketing problems of the oil industry and has successfully promoted many well-engineered and proved products to these divisions of the industry with their divergent and individual problems. He has been a director of the National Industrial Advertisers Association and his many friends know him to be an earnest advocate of sound and consistent advertising that gives the pertinent and essential facts to busy management.

Opens regional office

R. E. Hoffmann

The Superior Engine Division of The National Supply Company has opened a southeastern regional office at 531 Gravier Street, New Orleans, according to an announcement by Robert M. Pearson, manager of sales. R. E. Hoffmann, who has been manager of the division's office at Jacksonville, Florida, will be manager of the new regional office. A well equipped parts department has been established at the new office and complete sales and service facilities are available.

J. F. Tucker, Jr., field service engineer for the oil field machinery and equipment division of The National Supply Company, also will have his office at the new address.

Directs public relations

Appointment of Holmes Brown as director of public relations of the American Locomotive Company is announced by President Robert B. McColl. He succeeds Lynn Mahan, who has resigned to form his own public relations organization.

In his new assignment Brown will supervise all advertising, sales promotion, and publicity activities. George Mason was appointed assistant director of public relations. He is also director of information.

Brown has been associated with American Locomotive since October, 1945, when he became director of advertising and sales promotion.

President of Magnolia Airco

J. F. Pryor, Houston, Texas, has been elected president of Magnolia Airco Gas Products Company. W. A. Sherman and R. F. Crow, former president and executive vice president who have been closely associated with the company for many years, will continue this active association as directors.

Also appointed vice presidents are R. A. Merritt, former general manager of sales at Houston, and J. D. Schwartz, former branch manager at El Paso.

Kerotest general sales manager

George R. Allen has been appointed general sales manager of the Kerotest Manufacturing Company. Allen, associated with Kerotest for the last several years, was formerly sales manager of the brass valve division.

The statement, released by Stanley J. Roush, executive vice president, said that the appointment was made in a move to combine the entire sales operations of the company for both brass and steel valves under one head.

The growing emphasis on LP-gas was also a factor that helped set a policy of overall sales operations plus a growing trend of intermingling brass and steel in smaller valve applications in many types of industries.

Allen is a graduate of the University of Michigan and has spent all his business life in the valve industry.

"Oilwell" personnel changes

Several changes in Oil Well Supply Company personnel in Oklahoma have been announced by Mark Barkhurst, manager of the Mid-Continent Division of this U. S. Steel subsidiary.

Will Bristow, native of Maud, Oklahoma, has been appointed store manager of Healdton, Oklahoma. He replaces T. H. Haralson.

Bristow was employed by Oil Well Supply Company in July, 1937, at Seminole, Oklahoma. In 1942 he was made manager of the Seminole stores. Later he was made manager of the Wewoka store and in 1944, manager of the Anadarko installation for Oil Well Supply. He has been at Anadarko since 1944.

Haralson became connected with Oil Well Supply on July 1, 1944, at Wewoka, Oklahoma. On August 1, 1946, he was made manager at Madill, and on September 1, 1946, at Healdton. Haralson is being transferred to Oklahoma City to become field representative in the sales department.

James W. Hull, native of Deer Creek, Oklahoma, has been appointed store manager at Anadarko, succeeding Bristow. Hull became connected with "Oilwell" at Anadako on May 1, 1944.

To operate Joshua Hendy plant

Westinghouse Electric Corporation will take over operation of the Sunnyvale, California, plant of the Joshua Hendy Iron Works under a lease arrangement.

Westinghouse is entering into a 10-year lease with option to purchase the California plant, according to a joint announcement by John A. McCone, president of Joshua Hendy, and Harry F. Boe, vice president in charge of the Westinghouse Manufacturing and Repair Division.

The 57-acre plant will be operated under the direction of Boe and will become the largest of 37 manufacturing and repair plants that Westinghouse operates in 25 states, in addition to its principal manufacturing divisions.

In addition to carrying on Joshua Hendy's present production of such heavy equipment as pipe-line valves and smaller types of steam turbines, Westinghouse plans to expand its operation by adding new products now being manufactured in a number of other Westinghouse plants.

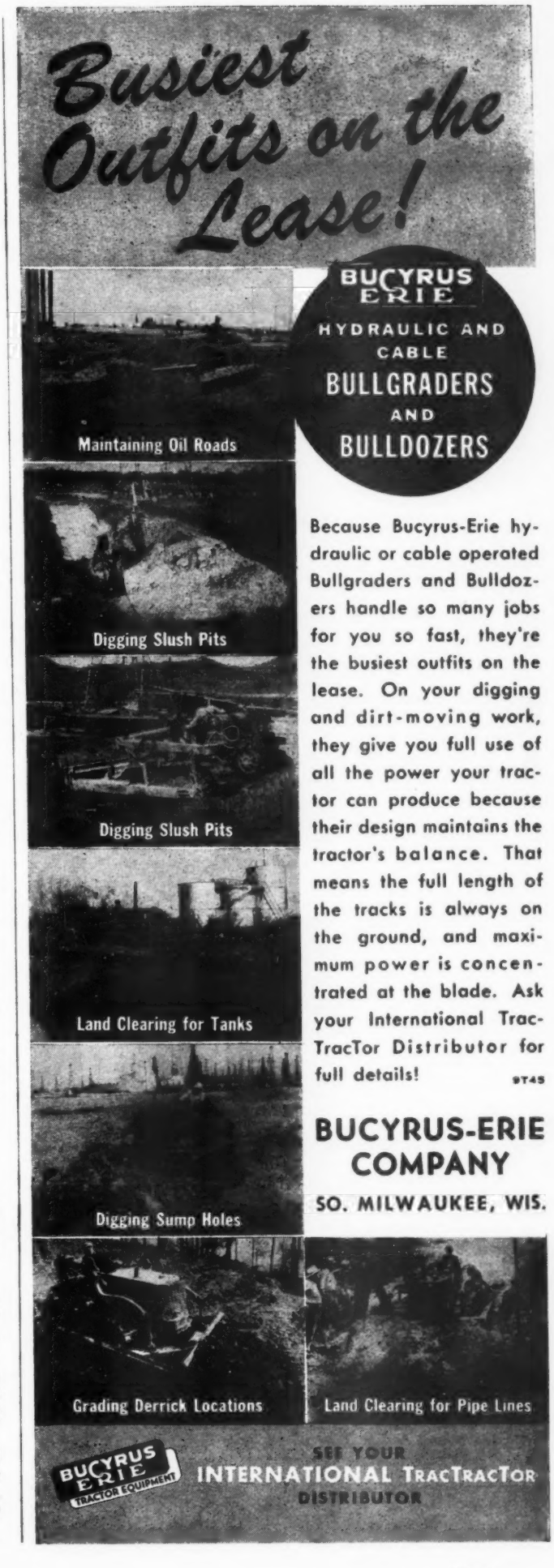
Safety awards given

The vital importance of employe safety was the theme stressed by Frederick A. Stevenson, president of American Car and Foundry Company, in awarding the Stevenson Safety Trophy to men in two plants of the ACF Group in St. Louis and Madison, Illinois.

The ACF St. Louis Foundry won the award for the third time in five years for plants in Group 2 with a record of three lost-time accidents for a total of 811,120 manhours worked; a frequency rate of 3.69 and a severity rate of 0.32.

The ACF Madison plant received the award for plants in Group 1 with a record of seven lost-time accidents during 1946 for a total of 1,389,711 man-hours worked; a frequency rate of 5.04 and a severity rate of 1.60.

In making the awards Stevenson expressed his pride and deep satisfaction in the fact that "This was the twentieth year since the safety contest among ACF Plants had been inaugurated and that the interest and enthusiasm among all ACF Plants was as strong as ever."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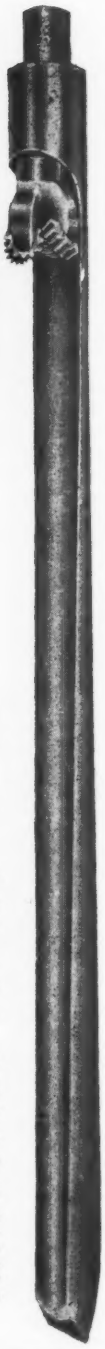

offers the operator 3 definite time and money-saving advantages...

1. The large size of the bit is valuable in difficult sidetracking jobs off of a cement plug.
2. The elimination of the reaming operation saves costly rig time.
3. The high rate of drilling and scientific deviation, made possible through the use of this whipstock, results in better mechanical condition of the hole, protecting against twist-offs and trouble when the well is put on production.

The Eastman Full Gauge Removable Whipstock is a rugged, dependable tool of solid steel, similar to the regular Eastman Whipstock in design and construction, but especially designed for use with a larger drilling bit. This makes it possible and easy to follow the whipstock bit with a FULL GAUGE drilling set-up — a great time saving factor in all directional drilling programs.

Other Eastman Services Include

Full Gauge Knuckle Joint and Full Gauge Driftmaster—for sidetracking, straightening and controlled directional drilling.

Single Shot and Multiple Shot Survey Instruments—for recording both direction and deviation of the bore hole.

Drift Indicators—for recording deviation when directional information is not required.

Orientation Services . . . Temperature Surveys . . . Pre-Cementing Reamers . . . Casing Roller Service . . . Bits and Reamers.

22 OFFICES FOR YOUR CONVENIENCE

Eastman OIL WELL SURVEY COMPANY

DENVER • LONG BEACH • DALLAS • HOUSTON

Petroleum Production Pioneers officers

At an executive meeting of Petroleum Production Pioneers, held in the Jonathan Club, Los Angeles, J. E. Gosline, southern district manager for Standard of California, was elected president of the organization for a second term. Elmer L. Decker, Martin-Decker Corporation, was named vice president, and O. W. Morgan, Jr., Byron-Jackson Company, and L. M. Coker of the same company, were elected sergeant-at-arms, and assistant sergeant-at-arms, respectively.

The incumbents, as follows, will retain all other offices through the current year: C. S. Perkins, Union Oil Company, treasurer; E. W. Webb, Continental Oil Company, assistant treasurer; R. Sneddon, *The Petroleum Engineer*, secretary; T. A. Atkinson, General Petroleum Corporation, assistant secretary; Ted Sutter, Baker Oil Tools, Inc., historian; H. H. Roberts, Standard of California, publicist; J. J. Siegel, Kobe, Incorported, chairman of the membership committee.

Denver sales office

Republic Supply Company, Houston, Texas, announces the extension of its supply service to the upper Mountain States area with the opening of a sales office in Denver. The new office is at 639 Continental Building and Denver H. (Friday) Hyler is in charge.

Hyler has been transferred from Republic's district office in Wichita Falls where he handled refinery and industrial sales. Prior to joining Republic in 1945, Hyler spent 30 years in active refinery operatons and was connected with the Continental Oil Company for 21 years where for 19 years he was in charge of that company's Wichita Falls refinery.

With the opening of the new Colorado sales office, Republic Supply now serves the oil industry with more than 50 sales and service points in ten states.

Flow meter handbook

A recent order received by The Foxboro Company, Foxboro, Massachusetts, marked the sale of the 18,000th copy of "Principles and Practice of Flow Meter Engineering." This handbook is widely used in every industrial field, and its distribution reaches to the farthest corners of the globe. It is the constant companion of operating men in the field; it is used as a textbook in engineering schools. Apparatus manufacturers whose flow problems affect the design and performance of their equipment regard the handbook as an essential every-day tool.

The first Foxboro flow meter handbook, "The Orifice Meter," was published in 1921, in the days when information for calculating orifice coefficients was considered a trade secret, to be sold with the meter. The book, which gave the public its first fully correlated data for performing all necessary orifice meter calculations, made of the industrial world one huge laboratory, with meter-users everywhere helping to check the accuracy of results.

Based on thousands of reports from users, many changes and improvements have been made in the 25 years since Foxboro first made this flow meter data conveniently available.

Southern California A.I.M.E.

The Southern California Section of the American Institute of Mining and Metallurgical Engineers held its first general meeting at the University Club in Los Angeles on February 25.

The speakers for the evening were Horace Dunbar and Rush M. Blodget who recounted interesting and not previously revealed episodes of the early days of oil and mining in California and Utah.

Horace Dunbar who was mining editor of the *Salt Lake Tribune* at the turn of the century told of the development and financing of the great copper mines of Utah. Of special interest were his stories of the personal rivalry for the corporate control of the mines.

Rush Blodget covered the early days of oil discovery and development of the San Joaquin Valley oil fields. He worked as a clerk in the old Kern Valley Bank, a partnership of Solomon Jewett and Hugh A. Blodget, an uncle of the speaker. His descriptions of the free and easy borrowing and cursory bank examinations would turn present day bankers green with envy —if they could stand the nervous strain.

Both men are especially qualified to review the early days

and the members and guests enjoyed these personal accounts of what went on behind the scenes.

Stuart Ingram, vice chairman for mining of the Southern California AIME and program chairman, announced that this cut-back to the early days was arranged to lay a background for future meetings at which current problems that confront the extractive natural resource industries will be covered.

Model parts department

As an educational service to their distributors, the Detroit Diesel Engine Division of General Motors recently announced the opening of a model parts department at the company's factory in Detroit, Michigan. Attractively appointed and incorporating the features necessary for effective parts merchandising, the display provides a working model that supplies parts for Detroit Diesel Engine Division's service repair shop, and which may be easily and inexpensively copied by distributors in setting up their own parts distribution organizations.

A 16-page booklet graphically illustrates the layout and shows in detail how it can be readily adapted to any existing operation of comparable size. Dimensions of working areas, sizes of bins, recommended materials, and suitable merchandise displays are all covered in detail.

California refiners elect

The Independent Refiners' Association of California at its 11th annual meeting, held in Los Angeles recently, elected as directors: B. S. Devere, Pathfinder; D. S. Fletcher, Fletcher Oil; Clifford Hancock, Caminol; W. G. Krieger, Krieger Oil; C. A. Johnson, Socal; M. M. McCallen, McCallen Refining, and J. D. Sterling, Eagle Oil. Officers elected for 1947 are: C. A. Johnson, president; D. B. O'Neill, vice president and general manager; M. M. McCallen, vice president; Clifford Hancock, secretary-treasurer.

Honeywell vice president

L. M. Morley has been elected a vice president of the Minneapolis-Honeywell Regulator Company, Harold W. Sweatt, president, has announced.

Morley, vice president in charge of sales for the Brown Instrument Company, a wholly-owned Honeywell subsidiary at Philadelphia, will continue to supervise sales of the industrial control devices made by the Brown division. His newest promotion thus makes him an officer of the parent company as well as its subsidiary, Sweatt said.

Cooper-Bessemer price policy

Establishment of a "firm price policy" as a means of holding the price line both in connection with the sale of its diesels, gas engines, and compressors, and also the purchase of component materials and parts, is announced by The Cooper-Bessemer Corporation, Mount Vernon, Ohio, and Grove City, Pennsylvania, manufacturer.

Announcement of the new policy was contained in a letter sent to all its suppliers and customers by H. C. Jones and H. L. Winger, Cooper-Bessemer general purchasing agents.

"Effective at once, it has been decided by our corporation to adopt the firm price policy in quoting on all of our products for delivery this year," the communication declares.

"It is our belief that this is the best way to stop the increasing inflationary trend, even though this policy contains certain hazards in a heavy industry such as we are engaged in, where several months are required to manufacture a product after an order is received and where we are obliged to absorb further increases in labor and purchased materials.

"The prices which we will quote from now on will not be subject to any increase above the prices in effect on the date the order is received, except possibly for the prices on major purchased components, which we hope can be held to a minimum," the letter continues.

The announcement requests suppliers to cooperate in the program of holding prices down and declares that preference will be given to those who do so.

"Only by the establishment of such price policies can industry stop further inflation and get back to sound business practices of free and competitive markets on a firm basis," the statement declares.

TANDEM
COMBUSTION UNIT
MAINTAINS A HIGH FLAME TEMPERATURE ON EITHER
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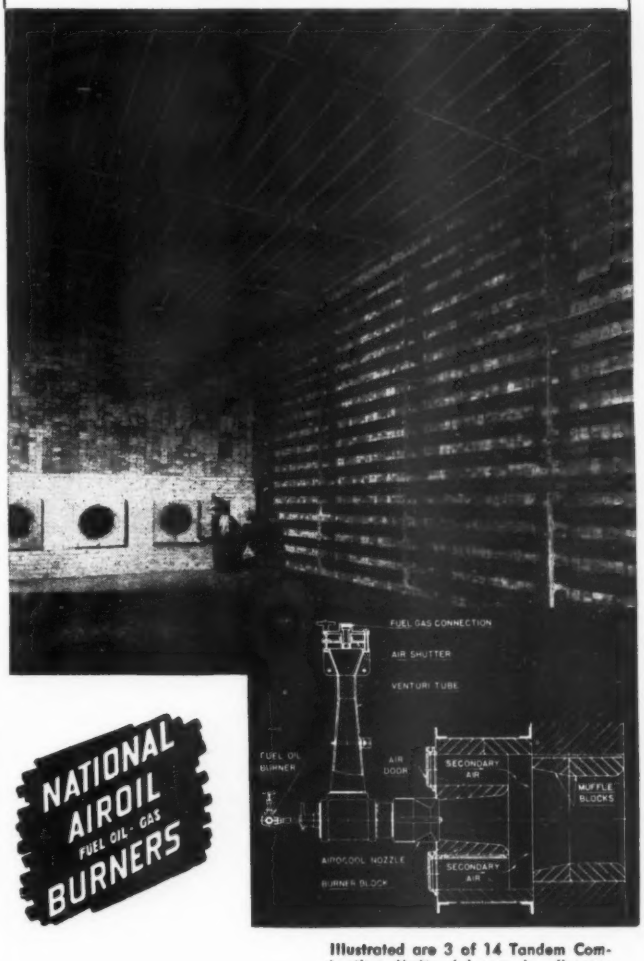

NATIONAL AIROIL FUEL OIL - GAS BURNERS

Illustrated are 3 of 14 Tandem Combustion Units (shown in diagram above) installed in a large Oil Cracking Furnace.

The Tandem Combustion Unit can be "lighted off" in a cold furnace and brought, quickly, to full capacity with a clean flame. It has a high turndown ratio with a steady flame, and can *maintain a high flame temperature with either gaseous or oil fuels*. The flame (regulated and directed) uniformly radiates heat to the absorbing surfaces without flame impingement.

Burning fuel oil, tar, sludge or gas, the Tandem Combustion Unit is extremely versatile, is economical of fuel and requires minimum supervision and maintenance.

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cuts true, fast,
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● It's less work to cut pipe with this new style RIGID that rolls through any pipe fast and easily, leaves practically no burr. Beautifully balanced special malleable frame, its heavy-duty tool-steel wheel always cuts true, every cutter factory tested. Choice of 5 sizes to 6" capacity—4-wheel cutters to 4." Save time and muscle—buy at your Supply House.

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WORK-SAVER PIPE TOOLS
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Pacific Personalities

A little more than a year ago, there sprang into being in Santa Maria, the village that was made famous by Frank McCoy, a young and virile organization, called The Santa Maria Oil and Gas Association. It was conceived first in the fertile minds of three highly reputable lads—Walt Miller, Tide Water Associated process engineer; Dick Zinzer, Union Oil Company process engineer, and Ray Schallert, Southern Counties Gas Company measurement engineer, all of whom have that innate enthusiasm and curiosity of which worthwhile organization is born. First president of the association was Ken Evans of whose one time ping pong prowess we have spoken in this colum. Ken is manager of properties in the Santa Maria area for the Alphonso Bell interests, is a petroleum engineer of considerable experience despite his youthful appearance, and by all accounts did himself proud in his year of office. Assisting Ken were first vice president, Dick Zinzer, author of many papers on petroleum engineering subjects; second vice president, Don McFaddin, well known through his excellent work on CNGA, for which he functioned variously as technical chairman and program chairman; and third vice president, Walt Miller, who can explain the behavior of the hydrocarbons better than he can that of the people who work with them. Glad E. Jahr, local manager of Bethlehem Supply Company (we hear tell he is going to Wilmington soon as manager for the company there) was in charge of the records, and Mel Sween, associate petroleum engineer for Union Oil Company, took care of the funds.

The 1947 officers of this up-and-coming body are Don McFaddin, president; Glad Jahr, first vice president; D. G. "Blackie" Jackson, division superintendent of Sunray Oil Company, second vice president; Ben Livesay, superintendent of the Macson Oil Company, third vice president; Mel Sween, secretary; and Bill Snowden, superintendent of Hancock and General properties in the area, treasurer. An excellent series of programs has been arranged for this year, and meetings are held on the third Wednesday of each month at Santa Maria Junior College, in the social hall. Visitors from other districts are welcomed, so, while we know it is mighty comfortable sitting there in the Santa Maria Inn with the copper kettles—and other interesting things—we would certainly suggest that you time your next trip up the Coast to coincide with a Santa Maria O. & G. A. meeting. You will find a lot of congenial companship, and some coincidental education in which your time will be well invested.

●

From Algiers all the way comes a card from our traveling correspondent, Ted Lynton, who is rapidly becoming the No. 1 cosmopolite of the petroleum industry. Accompanied by Mrs. Lynton and Dennis, he spent an enjoyable Christmas in North Africa, stomping around old war haunts, and looking up old Army buddies. He expected to return to France, via Casablanca, Marakeck, Rabat, and Fez, by the end of December. This recalls what the one shriner said to the other shriner: "I don't know your name, but your fez is familiar." Ted is setting up a drilling school in Morocco with American drillers, and it wouldn't surprise us a bit any day now to see him leading a camel caravan of tool pushers, drillers, derrick men, and rousties, with black beards and burnooses, out Telegraph Road.

●

We dropped into the Lafayette Hotel in Long Beach the other day for lunch, and for a minute we thought we had mistakenly intruded on a directors' meeting of the General Petroleum Corporation. Under the chairmanship of Charlie Gandaubert, a goodly gathering of flying horsemen were gathered around a long table, and although eating may have been primary purpose of the congregation, it appeared to be subsidiary to the earnest discussion that was going on. With our limited knowledge of psychology, psychiatry, or whatever it takes to decide such matters, we would guess that the serious expressions carried by the group were imposed by the prospect of a fishing job, or at the least a directional change of unusual magnitude. Speaking of fishing jobs, Charlie Gandaubert dislikes them heartily in an oil field, but in a lake, a mountain stream, or even in the ocean—well, that's different! He has caught almost every variety of fish that frequents American waters, including kippered snacks, smoked halibut, and filet of sole with French fried potatoes.

●

On the same day, we charged into the Tide Water Associated Pipe Line Department at Wilmington, to spend an interesting few minutes with Frank Coyle, superintendent, and Bill Davidson, his right hand man. We found Frank looking hale and hearty, with that brown healthy color that only comes to a man who has spent years burrowing under trees for his golf ball. He still pursues the pellet when business, or lack of it, permits, and we understand that he can now use an eight-iron, and miss the ball with such terific force that

you would actually think he had missed it with a driver. Bill is also a capable exponent of the manly art of plowing with a niblick, and if our field advisers are giving us the right dope, he recently achieved the ambition of all golfers by making a hole in one—hour.

●

We had a nice visit recently with Lew Hilton, the transplanted Californian, who now boasts about the wonderful climate of Texas. Here for a family reunion during the Christmas season, and, incidentally, to take care of a few business matters, Lew appeared to be thoroughly enjoying his renewed contact with familiar places and people, and we had a gala time discussing our very similar interests. Lew is now a full fledged member of the Petroleum Production Pioneers, and seems to have collected during his early experience in the California fields a wealth of pertinent episode and incident that ought to make Ted Sutter happy, when it is made a matter of record.

●

Frank Carter, the singing geologist, is a lad for whom embryo quartets have tremendous affinity. Any time he sees three people gathered together, he just unconsciously migrates in their direction, and presently a strange emanation of discord proclaims that he has gone to work. Frank is a resident of the thriving city of Glendale, of which Los Angeles is a quite substantial suburb. It sprawls picturesquely on the banks of the Arroyo Verdugo, and has a population that is almost entirely composed of people. Many of them are oil men, and the others are nice people, too. It has been estimated that if all the automobiles in California were laid end to end, with no space whatever between them, it would be 5:30 p. m. at the corner of Brand and Wilson. All of which is preliminary to the announcement that Frank has taken over the important chairmanship of the classification committee for the AAPG Pacific Section.

●

Incidentally, the local mud smellers have gone literary. We have just received the first issue of the "Pacific Petroleum Geologist," an association news letter from the Pacific Section that is chock full of interesting information, and should be of real value to the members. The "*book*" is under the direction of Loyde Metzner and his assistants, who, together constitute an editorial board as imposing as that on the masthead of the *Reader's Digest*. The first number contains a well proportioned blend of association activities, personal news, and pertinent bibliography. It is the only oil publication we have ever known that has no jokes, and the members thus can read it right in their homes without having to keep it under a cushion on the davenport. We venture to predict that this experiment in membership taste will soon be voted a permanent part of the AAPG diet. There is nothing like a small news sheet to fill the gap between meetings and to foster that community of interest that is basic to the success of all such organizations.

●

From that well known Desert Rat, "John D." Rockfellow comes news that Mart Bowser, erstwhile toolpusher for Union Oil Company, was a recent visitor in Los Angeles, from his ranch in Drain, Oregon. We well remember the old days when Mart's good right arm used to carry the field team at Dominguez to not infrequent victory in the big contest for the Burnham Trophy. This trophy was donated by Major Burnham many years ago, and is still contested for annually by bowling teams from all part of the Western States, in a grand telegraphic playoff. All teams play on the same night in distant parts of Union's operating territory, and the results are wired into headquarters at Los Angeles while the games are in progress. It is an exciting occasion, and many a time we have covered the event for the company magazine. Returning to Mart, however, he was born back in West Virginia about the time of the Boston Tea Party—we're not saying exactly. Anyway, by 1904 he was busy in the Oklahoma oil fields, and had had four years of oil field experience in his own home state. Later he drilled water wells in Arizona, at Seligman, for the Santa Fe Railway Company, and finally found his way to California and Union Oil Company. After an interesting career, both as toolpusher and kegler, he retired, and has since raised more turkeys on his Oregon farm than he ever did on the bowling alley.

●

It is good news that Ed Masters is back in Shell company's Los Angeles area again after a prolonged stay in New York. We are anxious to learn if he has developed a Brooklyn accent, or if he has retained the purity of his West Coast oil field diction. There is not likely to be any change, for the lingo of the derrick groves is too vigorous to be affected noticeably by anything so trivial as environment. Be all that as it may, however, we welcome Ed's return to the local scene, and wish him the most of the best as he travels again the old familiar trails.

●

The ubiquitous Bill Pemberton is now down at Cape San Lucas in Lower California, traveling tandem with Erle Stanley Gardner, the well known mystery story writer, and a flock of aides including three secretaries. What the eventual outcome of this safari will be nobody could guess, but if Bill can be persuaded—and it shouldn't be difficult to do—to recite his adventures during the days when he was hired as court jester to the late Mr. Doheny, the mystery writer will have the substance for a fact book as strange as any fiction he could conjure up, and twice as funny.

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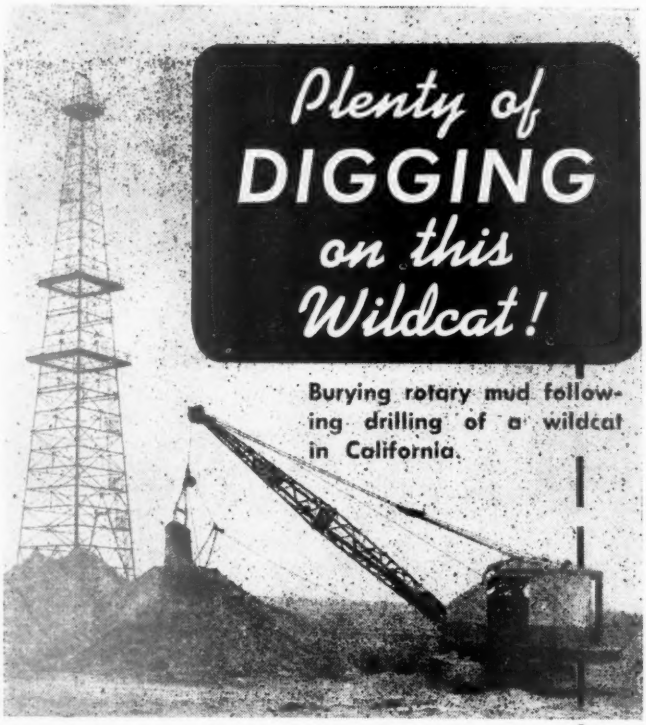

Like all oil-field drilling operations, putting down this California wildcat meant plenty of earth to move, fast. No wonder a fast machine was chosen for the job. The Bucyrus-Erie 22-B ¾-yard dragline pictured here is one of number of Bucyrus-Eries that have proved their ability to handle oil field excavating profitably. Featuring speed, operating ease, durability and in-the-field convertibility to various front-ends, Bucyrus-Erie ⅜- to 2½-yard excavators can bring you savings on the entire range of digging and lifting. That's why it will pay you to

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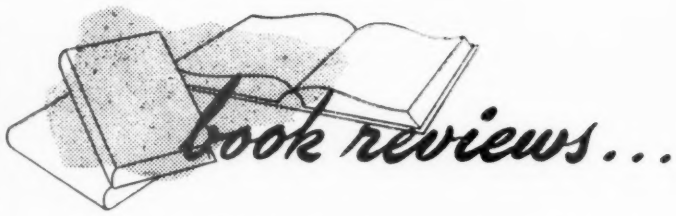

• **Summary of Technical and Patent Assets,** *1946 Edition, by Phillips Petroleum Company, Bartlesville, Oklahoma. Pages. 206.*

A brief review of Phillips patents, divided into 11 sections with a short discussion explaining each one, has been published by the oil company. Abstracts of the issued patents relating to each of the sections have been included for the purpose of giving a general idea of the value of the field covered by each patent. Photographs, diagrams, and descriptions of specific processes that have reached the commercial or semi-commercial stage are pleasingly presented.

• **The Co-ordination of Motive, Men and Money in Industrial Research.** *Published by Standard Oil Company of California, Los Angeles, California. Pages, 64.*

A slender book published by Standard of California is a survey of organization and business practices, based upon the working arrangements in 11 research organizations. The report deals with management practices as related to technical research activities, and is aptly illustrated with charts and diagrams to point up relationships. The publication is an interesting light on the comparatively new subject of research organization.

• **Modern Petroleum Technology,** *by the Institute of Petroleum Manson House, 26, Portland Place, London, W. 1. Pages, 466. Price, £1 1s.*

Written by men expert in their own specialized branch of the petroleum industry, the 35 articles in this book combine to present a comprehensive picture on the present state of petroleum technical knowledge. The various chapters cover exploration, geophysical methods, drilling, refining, utilization, distribution, oil measurement and economic features of the petroleum industry

The material makes available to members in any one branch of the industry the knowledge of those engaged in other branches and informs those desirous of obtaining a general overall picture of the technical aspects. Wartime advances in technical processes and general knowledge are included.

• **Diesel Operation and Maintenance,** *by Orville L. Adams. Published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11. Pages, 366. Price, $5.00.*

A clear and concise coverage of the basic principles and procedures, including the methods and techniques, of diesel maintenance and repair is contained in the above volume. It discusses standard inspection methods now used in the upkeep of pistons, liners, rings, and bearings. Guides to trouble-shooting include instructions on diagnosing fuel oil and lubricating problems, and the nature of the problems themselves.

The text is supplemented with charts, graphs, and many tables of valuable information for the experienced diesel engine operator and the student.

• **Oil for Victory.** *The Story of Petroleum in War and Peace, by the Editors of Look. Published by McGraw-Hill Book Company, Inc., New York. Pages, 287. Price, $3.50.*

The editors of Look have assembled within the covers of this book an extensive group of vividly illustrative photographs and drawings with explanatory captions forcefully telling the story of petroleum's contribution in World War II.

Some of the photographs are familiar, some are not, but they all show the magnificent drama of the industry. The mechanical side is portrayed as are the human task forces in uniform and in 'civies' who produced and consumed the oil, which kept the American arsenal running.

This is a new story that will appeal to any reader whether or not he is a member of the oil industry. It is interesting and dramatic, sound and accurate, a story of people who supplied World War II's most vital munition: Petroleum.

• **Identification and Qualitative Chemical Analysis of Minerals,** *by Orsino C. Smith. Published by D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. Pages, 351. Price, $6.50.*

Hundreds of natural color plates enliven this remarkable factual book about the 2000 known minerals. Classified by specific gravity and hardness, the minerals are also tabulated by physical properties for easy reference.

Best features of the wet method of group separation and the blowpipe and bead test in identification are combined in the author's system of qualitative analysis, which is unique in its simplicity.

Minerals that fluoresce under ultra-violet light are pictured accurately in full color plates for comparison with analytical results. With photographs, charts, and text, this book is most interesting and effective for direct practical use.

A.A.P.G. to meet in Los Angeles

For the first time since 1937 the American Association of Petroleum Geologists will hold its annual meeting on the Pacific Coast. This year, on the occasion of this group's 32nd annual gathering, the geologist will meet with two affiliated and closely related societies engaged in the search for oil, the Society of Economic Paleontologists and Mineralogists and the Society of Exploration Geophysicists. The meeting will be held at the Biltmore Hotel in Los Angeles, March 24, 25, 26, and 27.

This year, as they did ten years ago, California geologists will be hosts to visiting geologists, paleontologists, and geophysicists from throughout the United States as well as Canada and South America. Indications are that nearly 1800 delegates will be in attendance for the meeting to hear an interesting program of technical papers on subjects of importance in the field of petroleum geology, to be taken on a three-day field trip over some of California's oil fields and to transact many other projects toward the advancement of the science in which this group is engaged.

Tubular pipe shipped by air

An Egypt-bound transport plane recently took off from the Pittsburgh airport carrying the largest shipment of tubular steel pipe ever made to such a distant spot by air.

The tubing was urgently needed to repair a Suez, Egypt, petroleum refinery cracking still owned by the Anglo-Egyptian Oil Fields Limited. Work was at a standstill until the arrival of the tubing. Air freight was used because of the time element at a shipping cost that exceeded the actual cost of the pipe by a ratio of over 6 to 1.

When Pittsburgh Steel Company received the urgent request for the tubing, its plant officials, workers, and shippers swung into immediate action. Production was expedited to fulfill this order and the Contract Air Cargo Division of the American Airlines was called in to ship the tubing to the Egyptian refinery.

The finished pipe was delivered by truck to the airport in the morning. It consisted of seven tons of externally upset cracking-still chrome-moly tubing, each tube 30 ft long and 5 in. OD. In about two hours the tubing was loaded on the plane and specially braced to prevent it from shifting during the 7400-mile flight.

Shortly before noon, the pilot, Capt. Ernie Dryer, who is one of the oldest pilots in the business and one of the few with over 2,000,000 flying miles, took the plane off and headed for New York. There, an additional 500 lb of cargo was taken aboard and the haul continued to Suez, Egypt, by way of Ganda, Newfoundland; Shannon, Ireland; and Rome, Italy. Ten-hour crew rest stops were made at Shannon and Rome. The complete trip took about 33 hours flying time (about 50 hr actual time).

Al Brain succumbs

Albert Brain, president of O'Kane and Brain, drilling contractors, passed away recently after a brief illness. Brain was born near Rice Lake, Wisconsin, in 1890. He moved to California in 1910, and shortly thereafter began work in the oil fields around Taft, where he was employed by J. P. Samuelson, superintendent of transportation for the Esperanza Oil Company, later the General Petroleum Corporation.

After 19 months of service in the first World War, with the 26th Engineers, a year of which was overseas duty, he returned to General Petroleum Corporation as derrick man, and was shortly after promoted to driller, in which capacity he continued until October, 1922. At that time, W. W. O'Kane and Brain formed the drilling contract firm of O'Kane and Brain, which has served the industry without interruption since from its headquarters in the Jergins Trust Building at Long Beach.

Sales managers named

George W. Codrington, general manager, Cleveland Diesel Engine Division, General Motors Corporaton, Cleveland, Ohio, announces the appointment of T. E. Hughes as general sales manager and B. H. Gommel as commercial sales manager. Hughes was for many years manager of the Washington, D. C., office, and Gommel formerly was service manager. Their headquarters will be at the division's plant in Cleveland, Ohio.

J. S. Melton has been transferred from the Cleveland office to Hughes' old post as manager of the Washington office.

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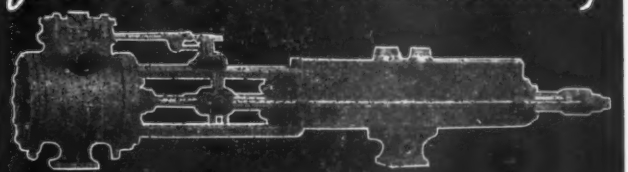

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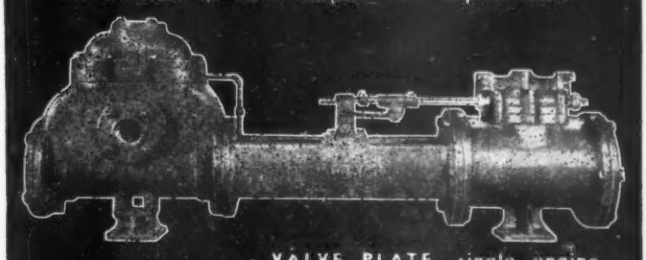

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Walter Elliot passes

Walter Elliot, general drilling superintendent of Shell Oil Company, Inc., and for more than 20 years an employe of that firm, died February 7 in Los Angeles following an operation.

Born in Sisquoc, California, February 2, 1888, Elliot was graduated from Stanford University in the class of 1911 with bachelor of arts and civil engineering degrees. He joined the Western Union Oil Company and continued with Shell when the Western Union properties were acquired by that company. In 1922 he was made superintendent at Santa Maria and in 1926 transferred to Long Beach. He was appointed general drilling superintendent in Los Angeles in 1928.

Ordovician symposium scheduled

The Pittsburgh Geological Society announces a symposium on the Trenton and Sub-Trenton of the Appalachian Area to be held on May 16, in the William Penn Hotel. Papers will be presented and discussed at morning and afternoon sessions and a banquet will be held in the evening. John T. Galey is chairman of the symposium committee.

The purpose of the symposium is to bring together all information possible on the Trenton and Sub-Trenton rocks of the Appalachian Basin from the surface section on the eastern and northwestern outcrop belt to the subsurface section across the Basin as interpreted by well records and sample studies.

Short course program plans

Program plans for the twenty-second annual Southwestern Gas Measurement Short Course to be held at the University of Oklahoma, May 6, 7, and 8, were drawn up at a recent committee meeting.

Approximately 60 subjects covering gas measurement and regulation and related work will be covered in classes and general assembly meetings during this year's three-day session.

The course is sponsored annually by the University of Oklahoma College of Engineering; the Oklahoma Corporation Commission; Kansas Corporation Commission; Arkansas Oil and Gas Commission; Oklahoma Utilities Association; American Gas Association, Natural Gas Section; the Natural Gasoline Association of America, and the Southern Gas Association.

I.P.A.A. directors to meet

Directors of the Independent Petroleum Association of America will hold their mid-year meeting in Jackson, Mississippi, May 8 and 9. Independent oil men to attend the meeting will represent all producing areas for the two-day session. Major B. A. Hardey, Shreveport, president of IPAA, has announced.

Plans for the mid-year meeting were crystallized at the recent executive sessions held in Los Angeles where the program committee met with Merle Becker, committee chairman, and executive vice president of W. C. McBride, Inc., St. Louis. Local arrangements for the Jackson meeting are being made by E. B. McGehee, vice president of the association for the State of Mississippi. McGehee is being assisted by local members and directors of IPAA.

A feature of the meeting will be a panel discussion on oil development and future prospects of the industry in the Southeast area of the nation including the states of Mississippi, Alabama, Georgia, Florida and Tennessee. Members of the panel to discuss this subject are now being selected from operators familiar with the area and its development to date.

The Jackson meeting will concentrate on the business outlook as reflected in the petroleum industry and in the development of new reserves. The program of the association, as formulated at the annual meeting held in Fort Worth last fall, will be reviewed and various committees engaged in the study of industry problems will report their progress to the directors. Nationally prominent speakers have been contacted to appear on the program, which is being held to a minimum length and indications are that this meeting will be exceedingly well attended. Selection of Jackson, Mississippi, for the mid-year meeting of directors was made in recognition of recent development and the growing importance of the southeastern areas to the oil industry.

The association, through Executive Manager C. E. Buchner, Tulsa, has announced that the annual membership meeting will be held September 29 and 30 in Oklahoma City.

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M. J. Norrell retires

Recently J. L. Latimer, president of the Magnolia Petroleum Company, presented M. J. Norrell, who retired from active service with the company December 31, 1946, with a plaque expressing the appreciation of the board of directors of Magnolia. Norrell was serving in capacity of secretary of the company and manager of industrial relations. It was announced by Latimer that Norrell will continue with the company for a few months on a special assignment.

Norrell is not only well known to members of the oil industry throughout the Southwest, but is very prominent in civic affairs.

Norrell became associated with Magnolia Petroleum Company on October 1, 1930, and was the first manager of Magnolia's industrial relations department. He retired under the company's annuity and insurance plan.

Expand Buffalo facilities

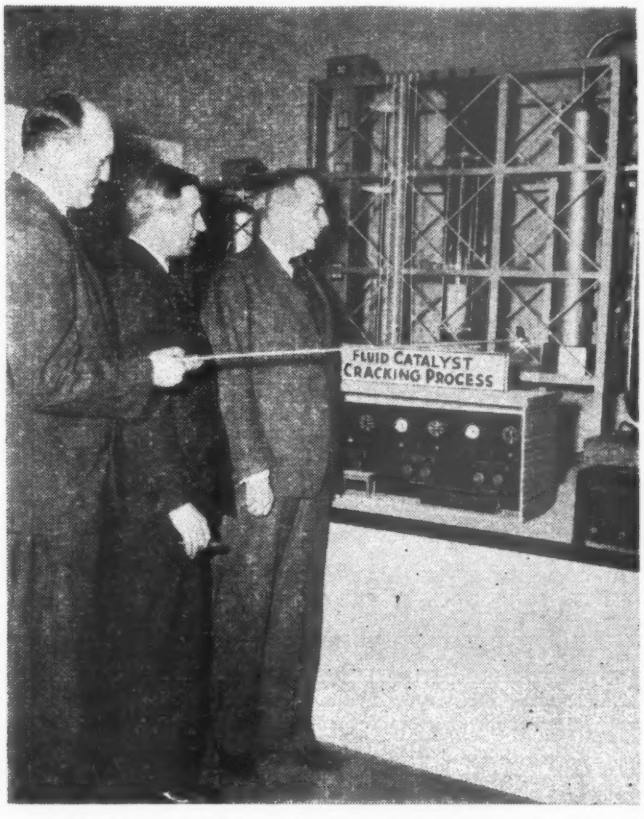
Plans to expand manufacturing facilities at the Westinghouse Electric Corporation's Buffalo, New York, plant have been disclosed by T. I. Phillips, vice president.

The new operation, formerly a part of the switchgear and control division at East Pittsburgh, will be known as the Industrial Control Division. To facilitate the transfer, L. R. Ludwig, manager of the motor division, has been assigned responsibility for this operation in its present location. Operations at Buffalo will eventually include motor, industrial control, copper wire and welding activities, and will be known as the Buffalo divisions, rather than the Buffalo motor division. Ludwig will be manager of the Buffalo divisions.

On Conference board

At the recent meeting of the National Industrial Conference Board held at the Waldorf Astoria Hotel, New York City, Charles J. Hardy, chairman of the board of American Car and Foundry Company was reelected to the Conference Board.

Esso training center opens



At the formal opening of the Esso Training Center in Elizabeth, New Jersey, on January 22, (left to right) M. J. Rathbone, president, Standard Oil Company of New Jersey; R. T. Stoner, director of industrial education, Pennsylvania State Department of Education, and C. R. Dooley, sponsor of the Training-Within-Industry Foundation, inspect one of the many scale-model exhibits used in the training of employes in various phases of the company's operations. Augmenting an expanding employe training program, the Center is manned by 18 permanent staff instructors and is equipped with the latest training aids and devices.

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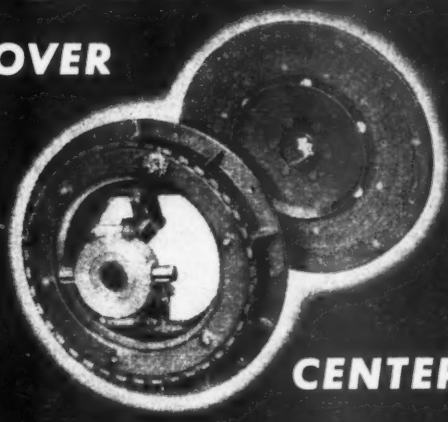
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the
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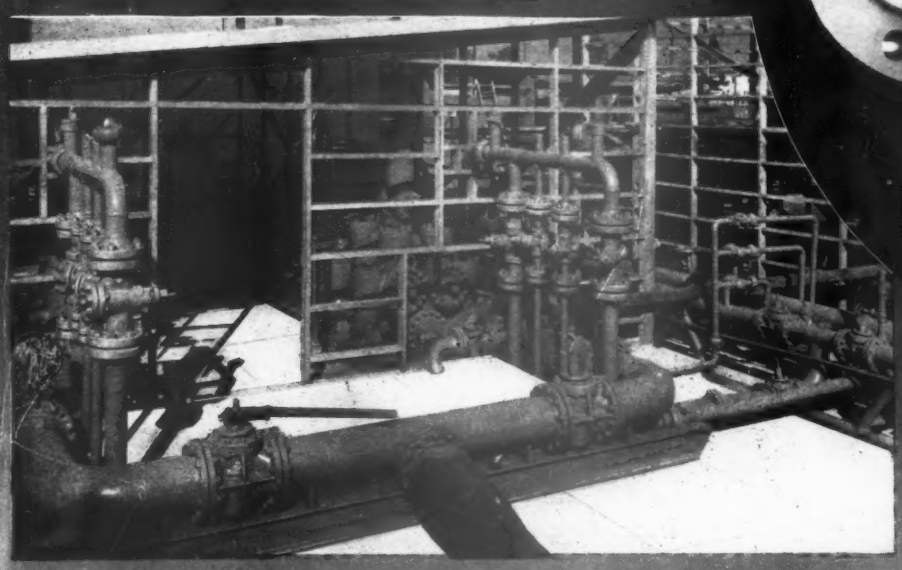
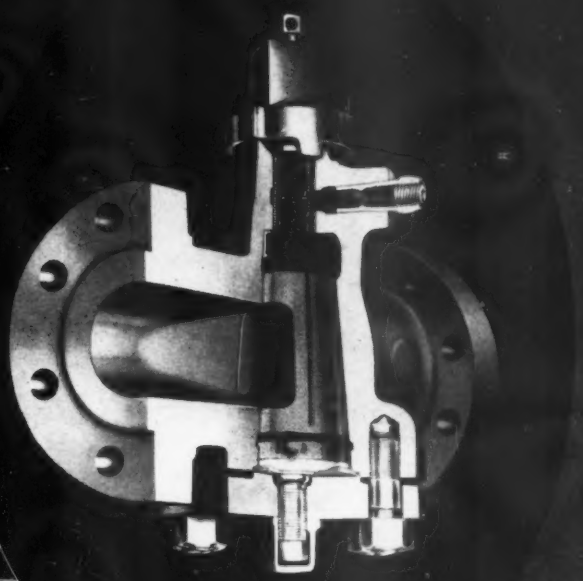
international monthly
devoted to petroleum operating practices

MUD LINES





HYPRESEAL TYPE

We have prepared a new Bulletin (No. V 201) featuring Nordstrom Merchrome Coated Valves for mud line service. It gives complete specifications; lists sizes, pressure ratings and prices. Ask for a copy.

KEEP UPKEEP DOWN

Nordstrom
LUBRICATED VALVES

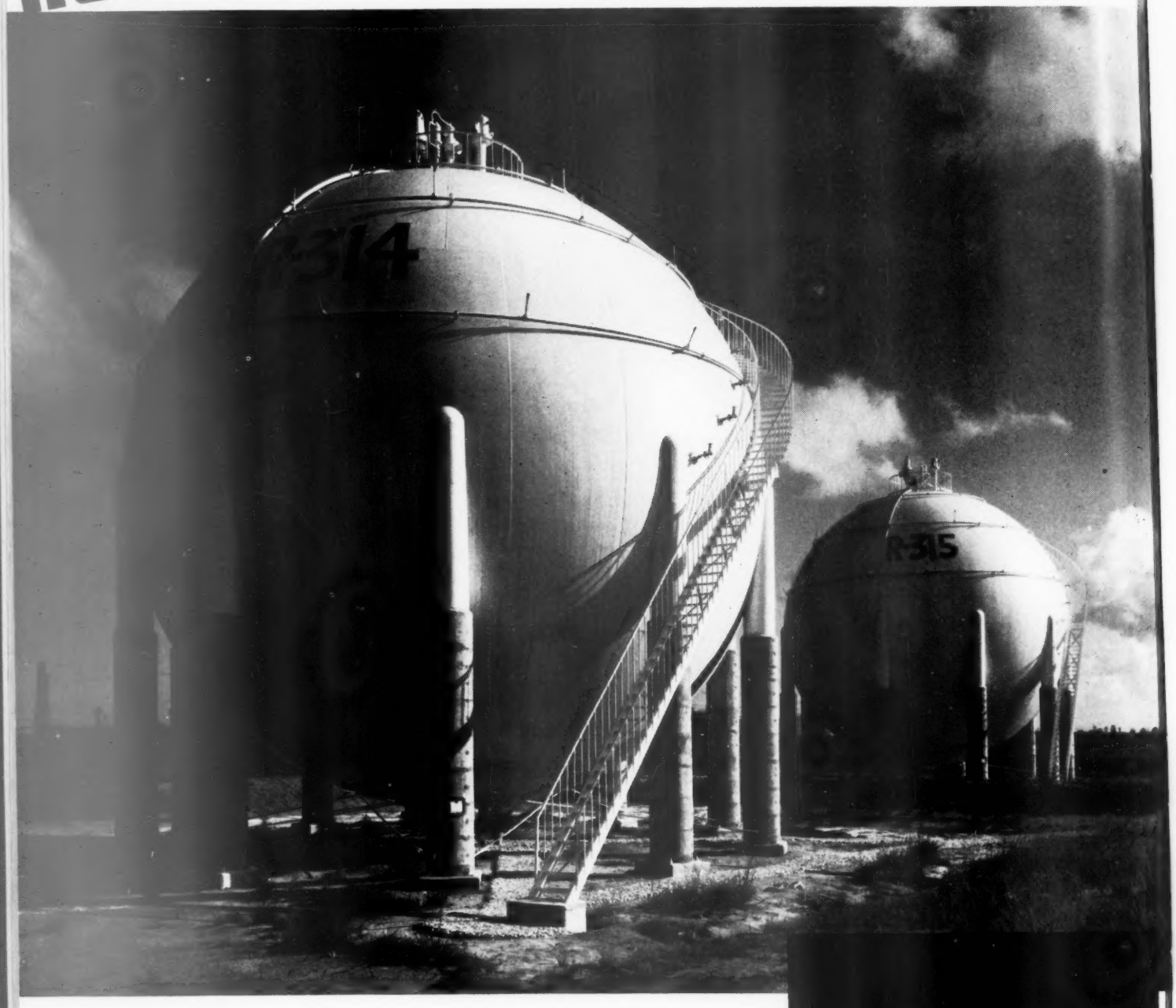
NORDSTROM VALVE DIVISION — ***Rockwell Manufacturing Company***

Main Offices: 400 North Lexington Avenue, Pittsburgh 8, Pa., Atlanta, Boston, Chicago, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa

. . . and Leading Supply Houses

Export: Rockwell International Corporation, 7701 Empire State Bldg., New York 1, N. Y.

THE HORTONSPHERE IS THE STORAGE TAN FOR HIGHLY VOLATILE PRODUCT



DID you ever stop to analyze why the Hortonsphere is the most widely used type of tank for storing and handling highly volatile products? The answer is simple. It provides top protection from evaporation losses, a reduction in fire hazard, long, trouble-free service and economy of operation.

Hortonspheres are installed for the storage of butanes, butane-propane mixtures and refinery charging stocks. They are built in standard capacities for pressures as high as 50 lbs. per sq. in. up to 65 ft. in diam., 100 lbs. up to 40½ ft. in diam. and 150 lbs. up to 28 ft. in diam. The two in the above photo hold 10,000 bbls. each.

Write our nearest office for Bulletin F which describes the Hortonsphere in detail.

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Plants in BIRMINGHAM, CHICAGO and GREENVILLE, PENNSYLVANIA

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Birmingham 1	1570 North Fiftieth St.	Havana	402 Abreu Bldg.	New York 6	3373—165 Broadway Bldg.
Chicago 4	2481 McCormick Bldg.	Houston 1	5637 Clinton Dr.	San Francisco 11	1264—22 Battery St. Bldg.
Cleveland 15	2251 Guildhall Bldg.	Los Angeles 14	1446 Wm. Fox Bldg.	Tulsa 3	1634 Hunt Bldg.

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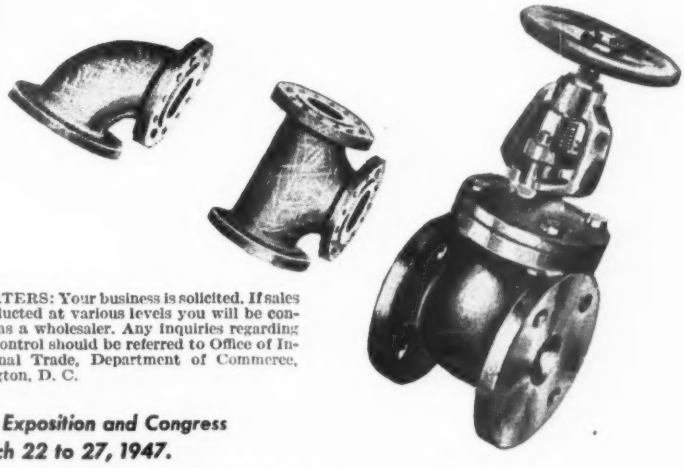
Chicago Bridge & Iron Company, Limited, Apartado 1348, Caracas, Venezuela
Ateliers et Chantiers de la Seine Maritime, Paris, France
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Leopoldo Sol & Cia., Reconquista 558, Buenos Aires, Argentina
Horton Steel Works, Limited, Fort Erie, Ontario, Canada
Whessoe, Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland

VALVES and PIPE FITTINGS

Low W A A PRICES MEAN *Extra* PROFITS

The War Assets Administration is today the world's largest single supplier of valves and fittings. For instance, you can buy those hard-to-come-by valves and fittings for water, oil and steam lines from *any* WAA Regional Office and, more important, you can get delivery NOW. Prices are so low that extra profits are practically assured either on re-sales or installation jobs. Purchases must total $300 or more. All items offered subject to prior sale.

Valve sizes: ½" to 24"
Fittings sizes: ¼" to 36"
Pressure ranges: 100 lbs. p.s.i. to 3000 lbs. p.s.i.



While every Regional Office has a supply of valves and pipe fittings, the largest inventories are located in these cities:

Atlanta	San Francisco
Birmingham	Portland, Oregon
Boston	Nashville
Chicago	Philadelphia
Cincinnati	New York

All valves and fittings are sold under existing priority regulations of WAA and of the National Housing Expediter. VETERANS OF WORLD WAR II are invited to be certified at the War Assets Administration Certifying Office serving their area, and then to purchase the materials offered herein.

EXPORTERS: Your business is solicited. If sales are conducted at various levels you will be considered as a wholesaler. Any inquiries regarding export control should be referred to Office of International Trade, Department of Commerce, Washington, D. C.

See our display booth at Western Metal Exposition and Congress Show at Oakland, California, March 22 to 27, 1947.

OFFICE OF GENERAL DISPOSAL

WAR ASSETS ADMINISTRATION

GOVERNMENT WAA SURPLUS

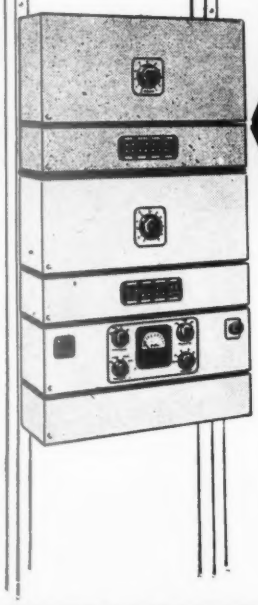
Offices located at: Atlanta • Birmingham • Boston • Charlotte • Chicago • Cincinnati • Cleveland • Dallas Denver • Detroit • Fort Worth • Helena • Houston • Jacksonville • Kansas City, Mo. • Little Rock Los Angeles • Louisville • Minneapolis • Nashville • New Orleans • New York • Omaha • Philadelphia Portland, Ore. • Richmond • St. Louis • Salt Lake City • San Antonio • San Francisco • Seattle • Spokane • Tulsa

827-3

HERE'S THE LOW-COST WAY TO GET

AN EXTRA TELEPHONE CHANNEL

"ON TOP" OF YOUR EXISTING SINGLE CHANNEL CARRIER



It's **FEDERAL'S SECOND STORY** Single Channel Carrier

FEDERAL'S 9-F-1 Second Story Single Channel Carrier Telephone System will provide an additional high-grade telephone channel, over open wire lines and radio links already equipped with a single channel carrier telephone system of the FTR 9-A-1 or other comparable types.

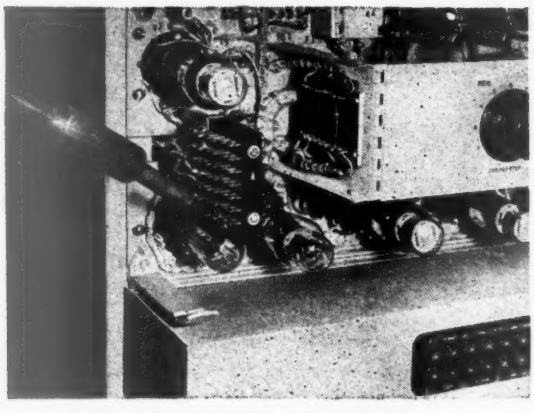
The simplicity and economy of this "second story" addition makes it the outstanding choice for telephone, railroads, utilities and pipe line companies who have outgrown their present communication facilities. And because it is a product of Federal engineering, you may be sure that it's built to perform to highest communication standards. Some typical Federal design refinements are listed below. For the complete details, write department H677.

AUTOMATIC PILOT CHANNEL REGULATION — To assure optimum performance under varying weather and temperature conditions.

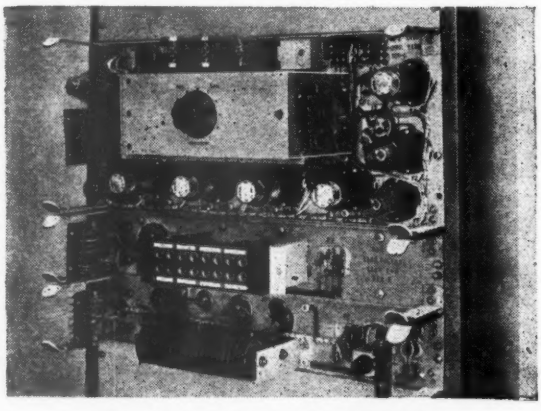
HIGH LEVEL OUTPUT—Maximum output level of plus 18 dbm provides operating range electrically up to 200 miles, or better than 800 miles with repeaters.

FLEXIBILITY OF OPERATION — Can be connected to meet various needs, as either an East or West terminal with 2-wire or 4-wire drop basis.

EASY MAINTENANCE — Tubes are easily accessible and all transformers, capacitors and similar components have been hermetically sealed to insure long life.



TERMINAL PANEL FLEXIBILITY



TERMINAL PANEL ACCESSIBILITY

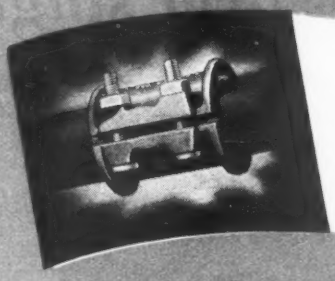
Arrangement of components permits maximum accessibility and utmost flexibility with operating features to meet many diverse performance requirements. Terminals are interchangeable and will provide 2 or 4 wire drop termination.

Federal Telephone and Radio Corporation

In Canada: — Federal Electric Manufacturing Company, Ltd., Montreal.
Export Distributors: — International Standard Electric Corp. 67 Broad St., N. Y.

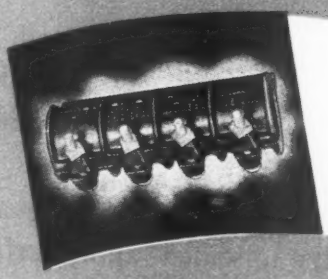
An IT&T Associate

100 Kingsland Road,
Clifton, New Jersey



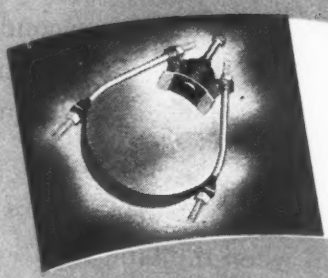
SKINNER-SEAL EMERGENCY PIPE CLAMP

For stopping leaks in pipe lines, instantly, permanently. Pipe sizes 1/2" to 12". Standard for forty years.



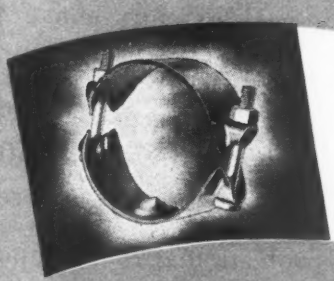
SKINNER-SEAL PIPE LINE CLAMP

For repairing long splits or very bad corrosion in pipe lines. Tremendously strong—for highest pressures.



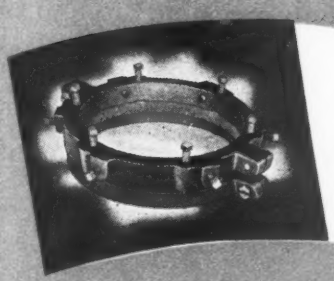
SKINNER-SEAL VENTED PLUG CLAMP

For stopping leaks in extremely high-pressure pipe lines—safely. No chance of injury or damage.



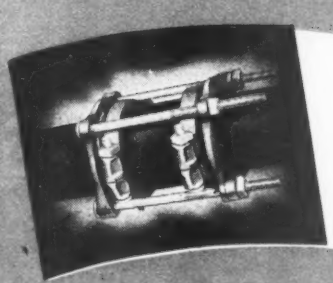
SKINNER-SEAL PRESSED STEEL ECONOMY CLAMP

For repairing badly pitted and corroded pipe lines at minimum cost. A strong, dependable clamp.



SKINNER-SEAL PIPE JOINT CLAMP

For stopping leaks at joints where pipe is screwed into a fitting. Without shutdown. Absolutely permanent.



SKINNER-SEAL COLLAR LEAK CLAMP

For stopping every type of collar leak, regardless of kind of collar or condition of line. Extremely rugged construction.

6 WAYS TO SAVE PIPE

AND MAKE LASTING REPAIRS, TOO!

With the continuing shortage of pipe, the SKINNER-SEAL method of repairing pipe leaks is invaluable. Saves pipe, saves labor, saves time. Skinner offers a clamp for every leak. The delivery situation is much improved. Write for Catalog 41.

M. B. SKINNER CO.

Established 1898

SOUTH BEND, INDIANA, U.S.A.

WIGGINS BALLOON ROOF

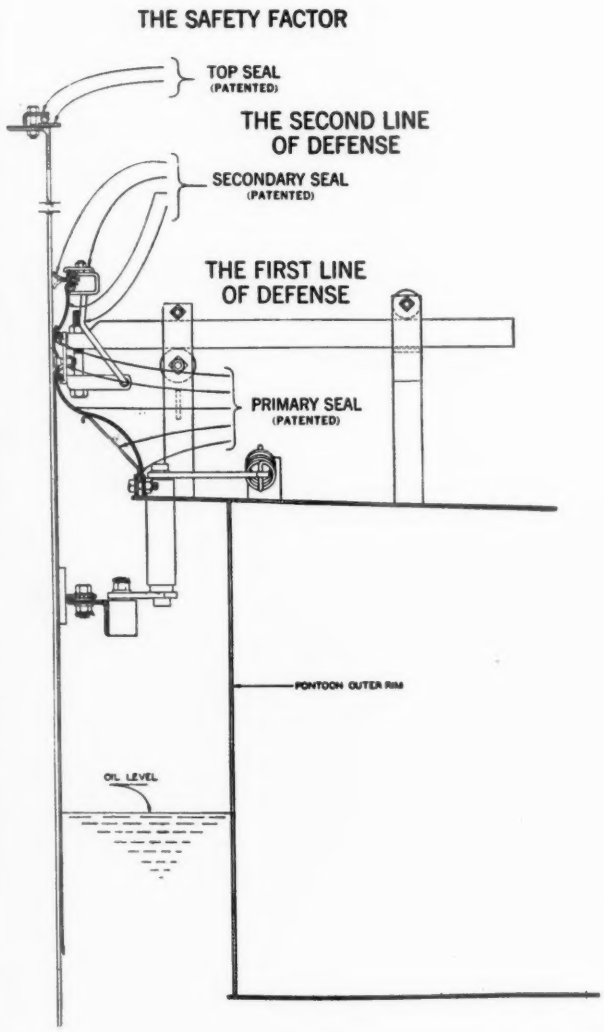
WIGGINS BREATHER ROOF

WIGGINS DRY SEAL LIFTER ROOF

WIGGINS DRY SEAL GAS HOLDER

Wiggins Triple Seal Protection

reduces evaporation losses over single seal by 50 per cent



Illustrated on the side is the triple protection afforded by the exclusive Wiggins Seals: primary, secondary and top.

The Wiggins primary seal reduces to a minimum the unsealed liquid surface.

By the use of the Wiggins secondary seal, evaporation from the unsealed liquid surface caused by wind action is nullified.

The top seal performs the duties of the secondary seal when the tank is full and the secondary seal extends above the shell top angle.

Wiggins Floating Roofs equipped with secondary seals show savings up to 50% over roofs equipped with only one seal.

This triple protection against evaporation losses is only available through General American Wiggins Floating Roofs.

Ask a General American engineer to tell you about other exclusive Wiggins features.

General American
TRANSPORTATION CORPORATION

135 SOUTH LA SALLE STREET, CHICAGO 90, ILLINOIS

BRANCH OFFICES: New York • Washington, D. C. • Cleveland • Buffalo • Pittsburgh
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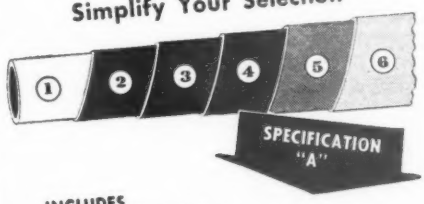
SOUTHERN STATES: Wyatt Metal and Boiler Works, Houston — Dallas, Texas
GREAT BRITAIN: Motherwell Bridge & Engineering Co., Ltd., Scotland
CANADA: Toronto Iron Works, Ltd., Toronto

WIGGINS GATX GENERAL AMERICAN VAPOR SEALS

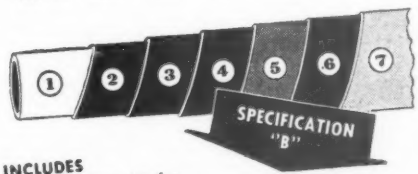
HOW TO SAVE TIME, TROUBLE and MONEY IN PIPE PROTECTION

Turn the Complete Job over to PIPE LINE SERVICE —and Forget It!

THESE SPECIFICATIONS Simplify Your Selection



INCLUDES
(1) Mechanical cleaning.
*(2) Mechanical priming with desired primer.
(3) Hot application of desired coating.
(4) Hot application of desired coating.
(5) One spiral wrapping of desired wrapping material.
(6) One spiral wrapping of heavy kraft paper.

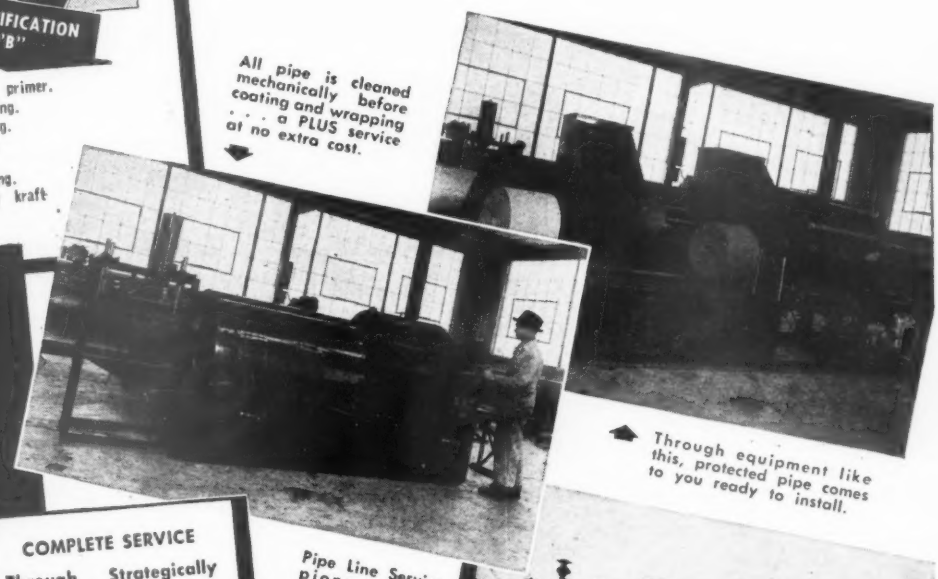


INCLUDES
(1) Mechanical cleaning.
*(2) Mechanical priming with desired primer.
(3) Hot application of desired coating.
(4) Hot application of desired coating.
(5) One spiral wrapping of desired wrapping material.
(6) Hot application of desired coating.
(7) One spiral wrapping of heavy kraft paper.

Here is a complete service that takes all the headaches out of pipe protection. You simply select either Specification A or Specification B together with the coating material desired. From there on, Pipe Line Service Corporation assumes full responsibility—secures the materials for you, furnishes the labor and takes care of every step right through to the finished job. No divided responsibility; no chance for slip-ups; satisfaction is guaranteed.

In every way, it will pay you to use this complete PLS service. It means only one order to write . . . one source of supply for your pipe protection requirements. Write for details.

All pipe is cleaned mechanically before coating and wrapping . . . a PLUS service at no extra cost.



Through equipment like this, protected pipe comes to you ready to install.

PROTECTIVE COATING MATERIALS Available on Above Specifications

Asphalts
Barrett Millwrap Enamel
Barrett Pipe Line Enamel
Barrett Waterworks Enamel
Bitumastic Regular Enamel
Bitumastic 70-B Enamel
Bitumastic XXH Enamel
Ennjay Enamel
*No-Ox-Id
Reilly Filled Pitch Enamel
Reilly No. 230 Enamel

* Primer not required with No-Ox-Id coatings.

COMPLETE SERVICE Through Strategically Located Plants

- Coating and Wrapping
  At the Mill
  At Yard or Railhead
  Over the Ditch
- Pipe Cleaning Service
- Pipe Storage
- Pipe Delivery

Pipe Line Service pioneered the mechanical application of pipe protection over the ditch. The new Traveliner is the finest equipment available for this purpose.

PIPE LINE SERVICE CORP. — SERVICE — EQUIPMENT — MATERIALS — FRANKLIN PARK-ILL.

PIPE LINE SERVICE CORPORATION

Pioneers in Steel Pipe Protection

General Office and Plant—FRANKLIN PARK, ILL.

Plants at: GLENWILLARD, PA., LONGVIEW, TEX., CORPUS CHRISTI, TEX., HARVEY, LA.

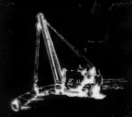
PRODUCTS LINE TERMINAL FITTINGS

GAS
LINE BLOWDOWN

24" SCRAPER TRAP

OIL LINE SCRAPER TRAP

4 WAYS TO MAKE UNIBOLT *pay off* to PIPELINERS



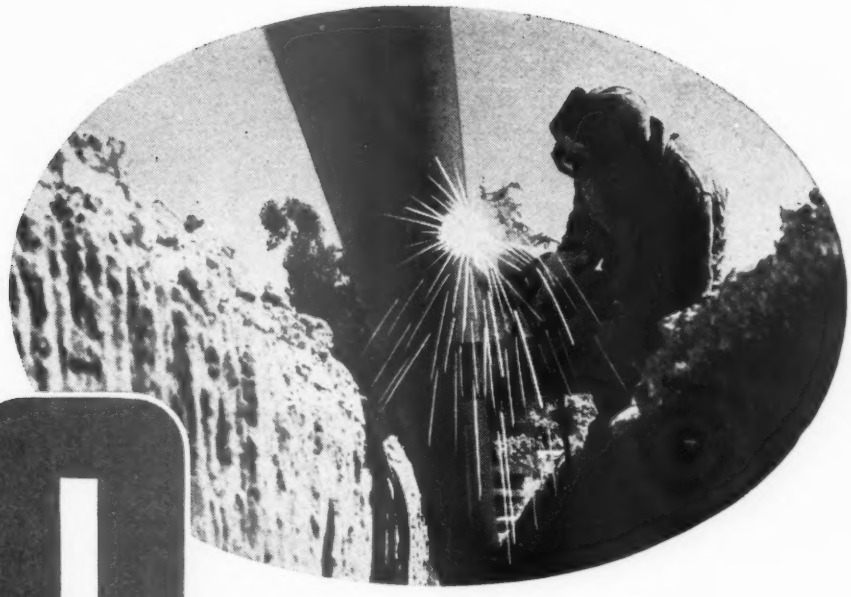
Several particularly advantageous applications of UNIBOLT Pipeline Couplings are illustrated at left. These unique couplings effect a leak-proof seal under all conditions by simply tightening a single bolt (2 bolts on 6" and larger sizes) thus applying sealing compression to a renewable resilient ring gasket. A blanking plug readily interchanges with the plain hub of the coupling to provide a dead-end for the line. Obviously, assembling and dismantling is quick and easy as compared with either a threaded or multi-bolt flanged closure, to say nothing of the more efficient sealing principle.

Complete details are carried in the new Thornhill-Craver Company Catalog No. D-46, a copy of which will gladly be sent on request.

THORNHILL-CRAVER CO.

HOUSTON, TEXAS

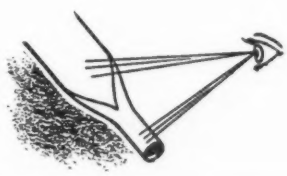
UNIBOLT



10 GOOD REASONS WHY

You Should Use Republic *Electric Weld* Line Pipe

1. **Uniform Roundness**—Pipe ends match up perfectly—speed construction—cut costs.
2. **Uniform Diameter**—No "off-size" lengths to cause welding difficulties at joints.
3. **Uniform Wall Thickness**—Absolute dependability throughout every inch of length and circumference.
4. **Uniform Strength**—Wall and weld are equally strong to resist high line pressures.
5. **Uniformly Straight**—Lengths line up evenly—go into the ditch freely.
6. **Easy to Bend**—High-ductility steel makes bending in the field easy.
7. **Easy to Weld**—Low carbon steel welds readily—makes sound joints.
8. **Freedom from Scale**—Insures against clogged valves, contamination of petroleum products.
9. **Long Lengths**—Reduces number of joints—makes jobs move with longer strides.
10. **Inspected Inside and Out**—Republic Electric Weld Line Pipe is made from flat-rolled steel both sides of which are closely inspected. Thus, you are assured that the surface which becomes the inside wall when formed into pipe, is free from hidden defects.



These are not mere claims. More than 40,000 miles of Republic Electric Weld Line Pipe installed in oil, gasoline, by-products and natural gas lines have proved every "reason why" time and again during a period of 17 years. Write us for further proof.

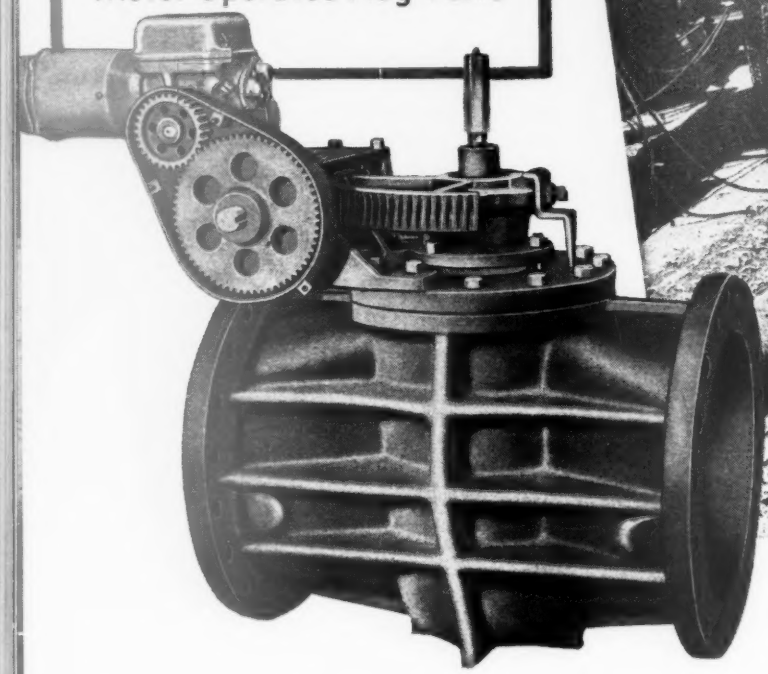
REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: New York 17, N. Y.

Republic
REPUBLIC STEEL
REG. U. S. PAT. OFF.
ELECTRIC WELD LINE PIPE

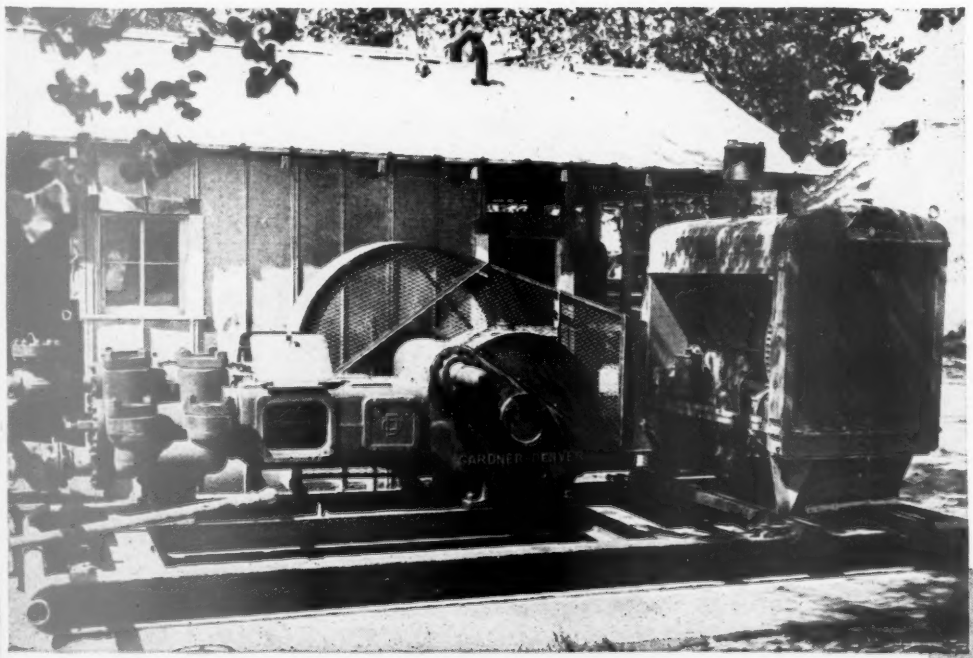
Other Republic Products include Carbon Alloy and Stainless Steels—Upson Studs, Bolts and Nuts—Electrunite Heat Exchanger Tubes

for Quality and PIPE LINE

NORDSTROM
Sem-Steel, Venturi Pattern,
Motor Operated Plug Valve



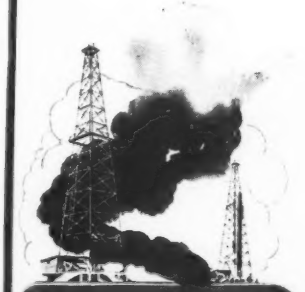
Youngstown Seamless Line Pipe being used in construction of a Pipe Line in West Texas



Pumping Unit consisting of 145 GKU Waukesha Engine with 4½ x 10 Gardner-Denver Pump installed in Rocky Mountain territory

THE MEN WE WORK WITH TO MAKE BETTER ROTARY DRILLING TOOLS . . .

THE OIL MAN who has Reached the Top



You men in the oil industry know him well. In fact men in all industries know him, for when he has something to say, men in industrial and government affairs pay attention.

You knew him and we knew him when he was on his way up. He worked long hours. He took chances in that most individualistic of all industries—oil. He knew discouragement as all men who lead must know. But more often he knew the thrill and joy of bringing in wells in proved, semi-proved, and wildcat areas.

We manufacturers are indebted to him. It is his kind that has made the oil industry great. He epitomizes all leaders and entrepreneurs in the great oil industry. He represents that great group of virile wealth-creating oil men whose efforts have not only made jobs for thousands of executives, engineers, superintendents, drillers, and roughnecks, but have in addition made jobs for men working in hundreds of plants manufacturing oil field tools and equipment. That this typical oil man who has reached the top regards his wealth as a sacred trust is made manifest by his charity, his philanthropy, and his interest in his city, his state and his nation. We hail the oil man who has won out in this industry where only men of great resourcefulness and determination succeed. There are many such and there are many on the way. We work closely with them to make better rotary drilling tools.

Reed

ROLLER BIT COMPANY

Working with the men in the field...

HAS ENABLED REED TO MANUFACTURE ADVANCED AND PRACTICAL ROTARY DRILLING TOOLS

REED ROCK BITS

give you faster, straighter full gauge hole with Less Weight

Because of the use of the Reed cross-roller principle, the Reed Rock Bit gets the hole down without depending on crushing action that requires heavy weights. This Reed principle gives a strong braced support which forces the cutters to take a path against their natural tendency to track. This causes the cutters to twist and tear the formation as they penetrate . . . making for faster digging with less weight.

REED *HAND-APPLIED* *Super Shrink-Grip* TOOL JOINTS

give you GREATER ECONOMY

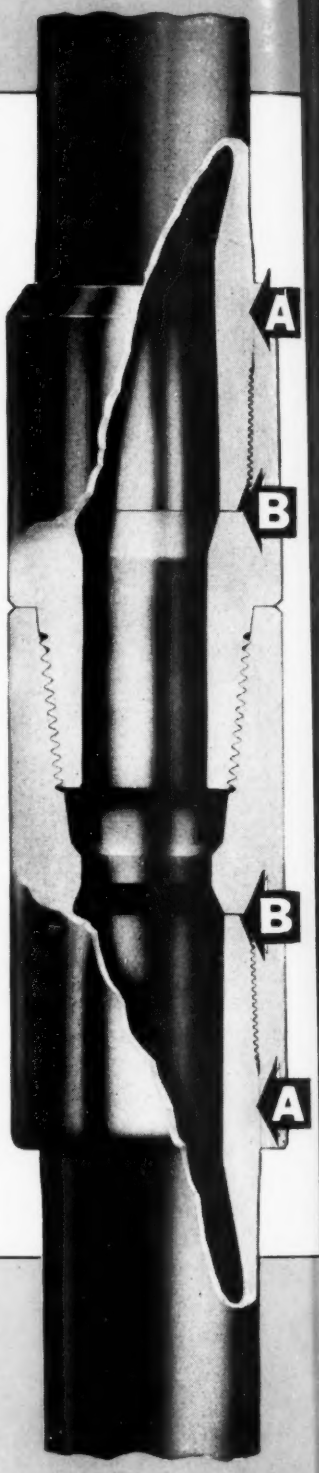
because they can be applied or replaced BY HAND in the field . . . reducing your transportation costs, application costs and shut down time.

. . . They give you **GREATER PROTECTION** against leakage and failure because of the DOUBLE SEAL, (A) and (B).

A **The Shrink-Grip "SAFETY AREA"** is an extended tool joint counter-bore shrunk onto a machined external upset on the drill pipe.

B **The GAUGING SHOULDER** upon which the end of the drill pipe lands, assures proper makeup and affords an added seal against leakage.

NO GAUGING OR SELECTIVE FITTING IS REQUIRED



Only **REED PIONEERING, REED RESEARCH AND REED MANUFACTURING EXPERIENCE CAN GIVE YOU REED RELIABILITY AND REED EFFICIENCY IN ROTARY DRILLING TOOLS**

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